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ABSTRACT

This learning module aims to engage students in problem solving, critical thinking, scientific inquiry, and cooperative learning. The module is appropriate for use in any introductory or intermediate undergraduate course that focuses on human-environment relationships. The module introduces the complexities in the relationships among environmental hazards and global changes. It presents five key concerns for geographers: (1) are societies becoming more vulnerable to environmental hazards and disasters?; (2) what social and physical factors influence changes in human occupance of hazard zones?; (3) how do people respond to environmental hazards and what accounts for differential adjustments and adaptation?; (4) how do societies mitigate the risk of environmental hazards and prepare for future disasters?; and (5) how do local risks and hazards become the driving forces behind global environmental changes? The module contains 11 tables, 2 figures, a guide, a summary, an overview, a glossary, references for all units, extensive supporting materials, and appendixes (selected Internet/WWW Hazards sites, selected readings on disasters and mitigation, and suggested readings). It is divided into thematically coherent units, each of which consists of background information, teaching suggestions, student worksheets, and the answers expected for each activity. (BT)

# HANDS-ON!

# Global Change and Environmental Hazards: Is the World Becoming More Disastrous?





## An Active Learning Module on the Human Dimensions of Global Change


DEVELOPING ACTIVE
LEARNING MODULES ON THE
HUMAN DIMENSIONS OF GLOBAL CHANGE

# Global Change and Environmental Hazards: Is the World Becoming More Disastrous?

Module developed for the AAG/CCG2 Project
"Developing Active Learning Modules on the Human Dimensions of Global Change"

by

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Developing Active Learning Modules on the Human Dimensions of Global Change
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# Editor's Note

A major goal of this project, "Developing Active Learning Modules on the Human Dimensions of Global Change," is to disseminate instructional materials that actively engage students in problem solving, challenge them to think critically, invite students to participate in the process of scientific inquiry, and involve them in cooperative learning. The materials are appropriate for use in any introductory and intermediate undergraduate course that focuses on human-environment relationships.

We have designed this module so that instructors can adapt it to a wide range of student abilities and institutional settings. Because the module includes more student activities and more suggested readings than most instructors will have time to cover in their courses, instructors will need to select those readings and activities best suited to the local teaching conditions.

Many people in addition to the principle author have contributed to the development of this module. In addition to the project staff at Clark University, the participants in the 1996 summer workshop helped to make these materials accessible to students and faculty in a variety of settings. Their important contributions are recognized on the title page. This module is the result of a truly collaborative process, one that we hope will enable the widespread use of these materials in diverse undergraduate classrooms. We have already incorporated the feedback we have received from the instructors and students who have used this module, and we intend to continue revising and updating the materials.

I invite you to become part of this collaborative venture by sending your comments, reactions, and suggested revisions to us at Clark. To communicate with other instructors using hands-on modules, we invite you to join the Hands-on listserve we have established. We look forward to hearing from you and hope that you will enjoy using this module.

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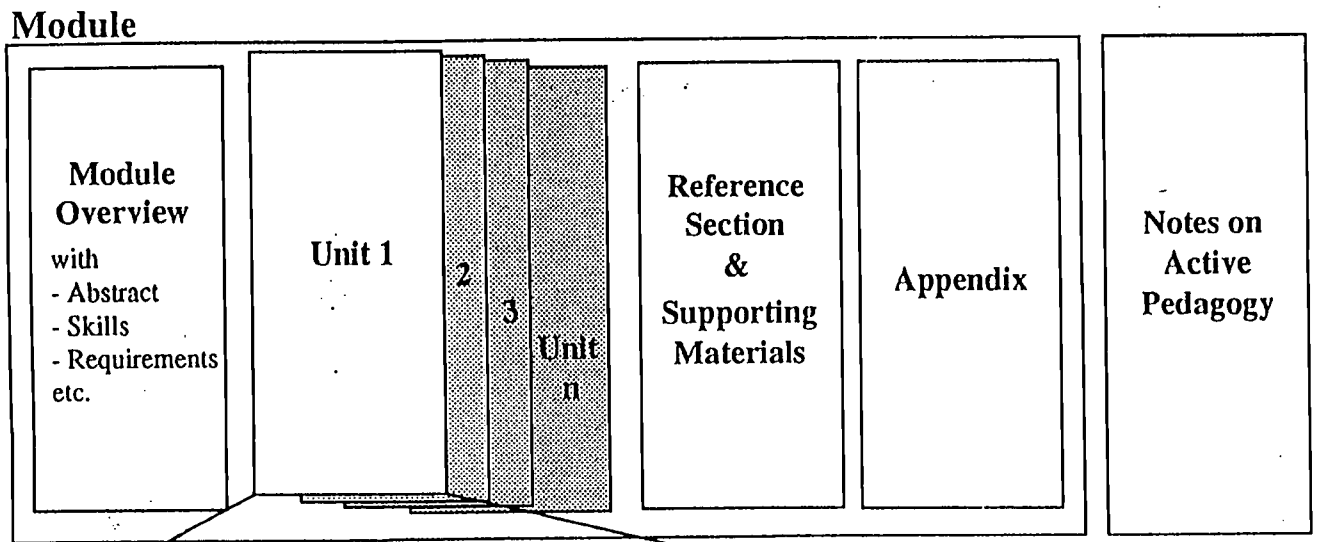
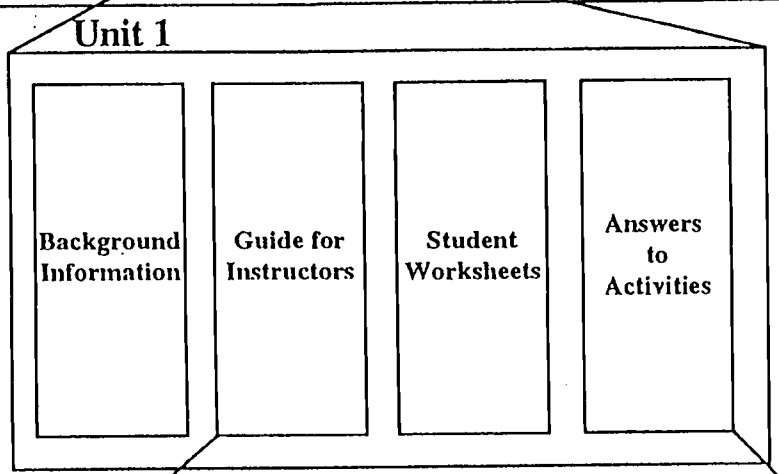
# Guide to this Module

This guide is meant to help you navigate this module.

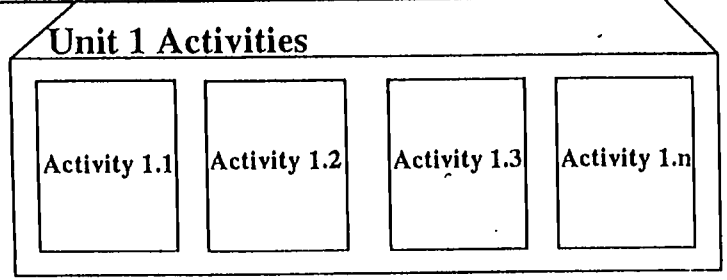



The module is divided into Units, i.e., sections that are thematically coherent and that could, if necessary, stand alone. In addition, the module contains a Reference Section, Supporting Materials and an Appendix. The Supporting Materials can be used to facilitate the teaching of this module or simply to augment it with interesting ideas and information. Additional sections with further information may or may not be present, e.g., a list of accronyms, or a glossary. A separate section on Active Pedagogy comes with every module purchase.




Each Unit consists of Background Information that can be used as a hand-out for students or as the basis for an in-class presentation; an Instructor's Guide, consisting of suggestions on how to teach the various learning activities associated with a given Unit; Student Worksheets; and the Answers expected for each activity.

Each activity has its own Student Worksheet for ease of preparing hand-outs for students.




The activities are geared toward the theme(s) and concepts discussed in a particular Unit. The particular skills and themes emphasized vary among the activities. Choose one or more activities per unit to fit your class size, time, resources, overall course topics, and student skill levels. Be sure to vary the types of activities you choose throughout the module.

# Summary: Global Change and Environmental Hazards:Is the World Becoming More Disastrous?


## Abstract

Environmental hazards, originating from both natural and technological sources, occur in all parts of the world. Global environmental change has the potential to exacerbate the effects of hazards on people and the environment. Driving forces such as population pressures and technological change are making certain groups of the people more vulnerable to hazard events. The links among natural, social, and technological systems are highly complex and present several key concerns for geographers:

- Are societies becoming more vulnerable to environmental hazards and disasters? If so, which hazards may intensify in the future as a consequence of global environmental changes?
- What social and physical factors influence changes in human occupance of hazard zones?
- How do people respond to environmental hazards and what accounts for differential adjustments (in the short term) and adaptation (in the longer term)?
- How do societies mitigate the risk of environmental hazards and prepare for future disasters?
- How do local risks and hazards become the driving forces behind global environmental changes?

This module introduces students to complexities in the relationships among environmental hazards and global change and illustrates why the questions above do not have simple answers.


## Module Objectives

By completing this module, students will

- gain a basic conceptual understanding of hazards, vulnerability, impacts, and mitigation strategies;
- learn about the spatial distribution and historical trends of hazard events;
- learn to assess how a number of social, (geo)physical, and technological factors are related and interact to determine the future prospects of hazards in a changing world;
- actively engage with the material through analytical, predictive, decision-making, and role identification tasks; and
- learn to approach critically the subject matter of global change and hazards by appreciating the diversity in human perceptions, experiences, and representations of human-environment relations.

## Skills

- ✔ decision making
- ✔ writing in different genres
- ✔ mapping
- ✔ websearch
- ✔ critical thinking/text analysis
- ✔ basic numeracy
- ✔ data plotting/graphing/scatterplot interpretation
- ✔ visual time series analysis
- ✔ role identification

## Activities

Types of activities designed for individuals, pairs, small groups, and/or the entire class include:

- ✔ role plays/simulations

- ✔ mapping
- ✔ text/media/movie analysis (including newspaper and scientific articles, vignettes, personal accounts, fictional texts, cartoons)
- ✔ group discussion
- ✔ numerical exercises
- ✔ graph production/interpretation

## Material Requirements

- ✔ Student Worksheets (provided)
- ✔ Suggested readings (some provided)
- ✔ Access to the Internet/World Wide Web
- ✔ Access to a variety of news media (papers, magazines, etc.)
- ✔ Film (optional)

## Human Dimensions of Global Change Concepts

- ✔ vulnerability
- ✔ environmental and human impacts
- ✔ adjustment/adaptation
- ✔ responses/mitigation

## Geography Concepts

- ✔ scale
- ✔ human-environment relations
- ✔ perception
- ✔ hazardousness of a place
- ✔ hazardscape

## Time Requirements

2 weeks (some activities can be adapted to last longer)

## Difficulty

Moderate. The module builds analytical, decision-making, and critical thinking skills. Students are asked to complete several numerical and computer-based activities with clear, step-by-step instructions.

# Module Overview

This module treats the relationship between hazards and global change; it introduces students to the complexities of environmental hazards, which arise from the multiple links among natural, social, and technological systems. Throughout, we retain a critical viewpoint, keeping in mind five key questions about hazards and their linkages to global change:

1. Are societies becoming more vulnerable to environmental hazards and disasters? If so, which hazards may intensify in the future as a consequence of global environmental changes?
2. What social/physical factors influence changes in human occupance of hazard zones?
3. How do people respond to environmental hazards and what accounts for differential adjustments (in the short term) and adaptation (in the long term)?
4. How do societies mitigate the risk of environmental hazards and prepare for future disasters?
5. How do local risks and hazards become the driving forces behind global environmental changes?

These questions are addressed mainly in the latter two of three units, which provide some answers, yet emphasize that simple explanations are impossible. Unit 1 introduces basic hazard concepts, hazard types, and characteristics, as well as the five key questions that form the core of research on hazards and global change. The unit raises the fundamental question of what environmental hazards are and uses insights from hazard research to demonstrate the variety of answers to this question; it then stresses the need for common definitions of hazard-related terms in order to investigate and communicate societal and physical trends.

Unit 2 ("Are things getting better or worse?") considers trends in hazard occurrences, impacts, and societal vulnerability to hazards. The relatively bleak picture that emerges at the end of this unit -- mainly as a result of the trends in societal vulnerability -- is the starting point for Unit 3, which considers how societies respond and adjust to environmental hazards. Unit 3 explains the ways in which humans respond to and mitigate hazards and emphasizes the differential vulnerability of various populations. Each unit includes *focus issues,* which highlight timely topics and provide specific examples.

The module provides students with a basic understanding of hazards, vulnerability, impacts, and mitigation strategies; it also gives students an opportunity to consider the complex relationships among social, geophysical, and technological factors and what these imply for future hazard events and experiences. Students actively engage with the material through mapping, role playing, media analysis, group discussion, numeracy, and graphing. Throughout, the module challenges students to take a critically aware stance on the subjects of global change and hazards.

# 1 What Are Environmental Hazards?

## Background Information

### Introduction to Environmental Hazards and this Module

The first half of the 1990's was riddled with unprecedented disasters -- earthquakes in Northridge, California (1994), and Kobe, Japan (1995); tropical cyclones and flooding in Bangladesh (1991); volcanic eruptions (Mt. Pinatubo in the Philippines in 1991); flooding during 1993 in the Northwest US and along the Mississippi River; and the most costly disaster to date in the US, Hurricane Andrew (1992), to name just a few of the most notable ones. Will climate change and other global environmental changes mean that we will see even more disasters in the future? Or are disasters like those mentioned above already evidence of the worsening interaction of hazards and global environmental changes?

The purpose of this module is to understand the nature, distribution, and impacts of hazards and disasters worldwide and to examine how global changes will affect human vulnerability to such events. To do so, we address this complex subject through the following five questions (see also Cutter 1996):

1. Are societies becoming more vulnerable to environmental hazards and disasters? If so, which hazards may intensify in the future as a consequence of global environmental changes?
2. What social/physical factors influence changes in human occupance of hazard zones?
3. How do people respond to environmental hazards and what accounts for differential adjustments (in the short term) and adaptation (in the longer term)?
4. How do societies mitigate the risk of environmental hazards and prepare for future disasters?
5. How do local risks and hazards become the driving forces behind global environmental changes?

These questions not only guide Units 2 and 3 and the accompanying activities, they also mark the frontier of contemporary hazards research.

In this unit, we lay the groundwork to address these questions. We begin by taking a critical look at people's perception of hazards and the implications of different perceptions on the measurement of hazard trends and on the individual, communal, and societal responses to hazards. Building upon that critical awareness, we then examine some commonly used terms and

concepts in order to have a common language with which to speak about past and future hazards trends and the ways in which we attempt to lessen the dangers of living in an ever-changing world. In this module, we use *focus issues* to highlight problematic aspects of being confronted with hazards. You may want to discuss the questions that accompany each focus issue with your classmates.

## When is Something a Hazard?

Before we look at specific hazards, hazard characteristics, and trends in hazard occurrences, let's begin with a simple yet profound question -- When is something a hazard? You may think it's a silly question. Floods, earthquakes, severe thunderstorms, pesticides, and toxic or oil spills immediately come to mind, somehow implying that all these things are inherently hazardous. At least two arguments challenge the notion that things are inherently hazardous, however. The first is that if no people (or things that people value, such as their homes and belongings, a beautiful landscape, or a clean beach) are harmed, then a phenomenon isn't hazardous; the event would simply happen without anyone or anything being affected negatively. "Well," you might say, "but what about animals or ecosystems?" That question simply proves the point; it indicates that you value animals or ecosystems as important, precious, or beautiful and that you feel something could harm them. From this perspective, a severe windstorm that topples trees, uproots vegetation, and injures creatures on the ground would be a hazard to animals and ecosystems.

The second argument challenging the notion that certain phenomena are inherently hazardous is a little less obvious but even more important than the first: what is a hazard to you may not be a hazard for me. Here are a few examples.

1. But, after all, there is at least one or two things about that weather (or, if you please, effects produced by it) which we residents would not like to part with. If we hadn't our bewitching autumn foliage, we should still have to credit the weather with one feature which compensates for all its bullying vagaries -- the ice-storm: when a leafless tree is clothed with ice from the bottom to the top -- ice that is as bright and clear as crystal; when every bough and twig is strung with ice-beads, frozen dewdrops, and the whole tree sparkles cold and white, like the Shah of Persia's diamond plume. Then the wind waves the branches and the sun comes out and turns all those myriads of beads and drops to prisms that glow and burn and flash with all manner of colored fires, which change and change again with inconceivable rapidity from blue to red, from red to green, and green to gold -- the tree becomes a spraying fountain, a very explosion of dazzling jewels; and it stands there the acme, the climax, the supremest possibility in art or nature, of bewildering, intoxicating, intolerable magnificence. One cannot make the words too strong.

   -- Mark Twain. 1876. *The Weather -- Address at the New England's Society's 71st Annual Dinner, New York City, December 22, 1876.* (Cited from *New England's disastrous weather*, p.226.)

2. They like to tell the one about the farmer selling apples under a big sign that reads 'Apples from Chernobyl.' 'You must be mad,' a passerby said. 'No one wants to buy

apples from Chernobyl.' 'Sure they do,' the farmer said. 'Some buy them for their mothers-in-law, some people buy them for their wives.' Others downplay the risk. 'All I know is that we've been eating the food around here for almost 10 years, and we feel fine,' said Olina Nikolayeva, 65, one of several hundred people who have moved back into the Ukrainian village of Opachichi, 15 miles from the reactor. 'You can eat the apples, but you have to bury the seeds deep in the ground,' Nikolayeva said. 'You can eat mushrooms, but only up to 10 kilograms. And if you feel too much radiation, you have to drink some vodka.'

-- Excerpt from Filipov, David. 1996. In Chernobyl soil, fatalism thrives. *The Boston Sunday Globe*, April 21: 17. © Reprinted courtesy of David Filipov. The Boston Globe 1996.

3. I grew up in the 1970s in Taipei. Every summer of my childhood it was unbearably hot and humid, and quite often a typhoon attacked Taiwan. Even though this was twenty years ago, I can vividly recall what happened to our home and neighborhood year after year until the government constructed underground waterworks. It happened almost every June. The rain brought by the typhoon flooded the school up to its second floor. All the houses in our compound were covered with water on the first floor. As soon as we were warned to expect a downpour, we started to clear the gutter around the house and tried to place our furniture on higher ground. All we could do was to grab our valuables; refrigerators, beds, and the piano all got soaked in the water. We had to spend the nights at our neighbors' home on the third floor. We counted the hours in the dark in fear and simply could do nothing else because of the black out and the suspension of the water supply. Some neighbors were more happy-go-lucky than we were and went as far as to sit around a table playing Majong by candlelight to kill time. The ruined furniture, electric appliances, and mud from the hillside formed a heap on the street. The talk of the day centered on how much each family had lost and whose car had been soaked with mud and water. The neighborhood stores got a lot of business since everyone rushed to buy and hoard food. The neighbors got acquainted with each other after going through the same experiences. After a while, everything went back to normal. Flooding was an event to go through each summer. It would be a surprise if there was no devastating typhoon in June. The government was never blamed, but instead when residents received food sent by the agencies, they expressed gratitude toward the government. The children were happy not to have to go to school. It was an opportunity for them to go rafting on the flooded streets. Seldom would neighbors speak of moving away because they could not afford to buy an apartment elsewhere. The nightmares of typhoons finally stopped haunting us in 1986 when the government finished the underground water works.

   -- A graduate student at Taiwan National University. 1996. Personal account of typhoon and flood memories. Provided by Nora Chiang, Taiwan National University.

4. I think the economic logic behind dumping a load of toxic waste in the lowest wage country is impeccable and we should face up to the fact that ... underpopulated countries such as Africa are vastly underpolluted.

   -- Lawrence Summers (Former Chief Economist of the World Bank) December 1991; cited in Puckett, Jim. 1994. Disposing of the waste trade: Closing the recycling loophole. *The Ecologist* 24, 2: 53-58 (quote from p.53).

5. **Floods in Bulozi (Western Zambia)**

It is floodtime in Bulozi
There is the floodplain clothed in
the water garment
Everywhere there is water!
there is brightness!
there are some sparkles!
Waves marry with the sun's
glory
Birds fly over the floods slowly,
they are drunken with cold air
they watch a scene which comes
but once a year
floods are tasty (nice, beautiful)
Bulozi is the floods' place of
abode
every year the floods pay us a
visit.

A Lozi does not beg for floods
We do not turn the herbs to have
floods
We do not practice witchcraft
whatsoever
They are floodwaters indeed!
The floods know their home area.
Floods are ours
the floods themselves
they (floods) know their own route
they know their home area
they know where they're needed
they know where they are cared for
And when we ourselves see them
we are inflated with happiness
our hearts become lighter
we do not fear floods ...

-- Excerpt from a poem translated from Sibetta, O.K. 1983. *Fa Manunga Wa Lyambai*, Lusaka, Neczam. Source: Namafe, Charles and Frances Slater. 1995. Floods: Friends or enemies? *Geographical Education* 8, 3: 57-62 (complete poem on p.57)

All of these excerpts demonstrate that a "hazard" isn't always a hazard and is definitely not always perceived as one. A hazard to some is to others a business opportunity, a spiritual moment, a joyful experience, a culturally significant if not defining moment, a down-played or even denied reality, "no big deal" at all, or just a common everyday kind of event. On the other hand, what is "normal" or even necessary to some is loaded with the most dreadful fears for another. Wildfires are a case in point; while certain tree species need fires for their seeds to be liberated from protective cones to insure the species' reproduction and survival, the owner of a multi-million dollar home destroyed by the same fire is likely to have a very different perspective.

We should inject a note of caution. To say that a hazard to some may be a completely different experience for another is a heavily *subjectivist* position, meaning that reality is simply what we say or think it is; it's all in our minds and there is no "external" foundation for whatever we perceive. To be sure, there are some thinkers who maintain such a position, but we do not adopt it in this module. Whether or not you perceive driving without a seat belt as hazardous, it does kill people; whether or not you perceive smoking as a hazard, countless studies show that your health is negatively affected by smoking. By analogy, to take a purely *objectivist* position and say that hazard perception is irrelevant because there is only one external reality and that's all we need to worry about is insensitive to the reality of human beings and their experiences.

Although in this module we repeatedly emphasize the importance of hazard perception, it is no longer the hottest or most pressing aspect of hazard studies.

Our perceptions of a hazard are influenced by factors such as personal experience with a hazard, varying knowledge of a hazard, different outlooks on the world (God, nature, technology, society, government, self, etc.), culture, gender, wealth, age, the personal and professional roles we have taken on, and adjustments and adaptations to the hazard we have managed. When we ask big questions like "Are things getting better or worse?" or "Is the world becoming more disastrous?" there can be no straightforward answer. We have to question the point of view from which someone would answer these questions, and we have to be aware of the context in which a statement is being made. For example, the answers to such questions are likely to differ between an insur*er*, an insur*ed* home owner, and someone who just *lost insurance* -- even though they may all speak about property losses from floods.

Similarly, responses to hazards will differ depending on people's hazard perception and personal circumstances. If you are 10 years old and a major blizzard keeps you at home because schools are closed, you might celebrate the day by building a snowman or hanging out with friends. If you are a parent who is expected to be at work and can't afford the loss of pay or a babysitter, that blizzard is not a source of joy!

The same caution about perceptions and responses applies to hazards associated with global environmental change. Scientists say that the effects of global climate change, for example, are likely to benefit some regions of the world while harming others. Superimposed on this unevenness in the effects of global change are differing perceptions of such changes, i.e., what we do and don't perceive, and how we judge these changes.

When we look at hazard trends, these differing hazard perceptions put us in a quandary. On the one hand we would like to appreciate differences in perceptions; on the other hand, in order to discern trends, we need measures of frequency or occurrence, and these measures need to be based on the same definition of a hazard over time to ensure comparability. In the next section we provide some common definitions of hazard-related terminology to allow us to look at trends from a common viewpoint and to connect with the scientific hazard literature. We will continue to point out, however, in the text and in the activities, how differences in perception of and responses to hazards and environmental change affect the discussion of trends and responses to hazards.

## Establishing a Common Language: Some Definitions

The terms risk, hazard, and disaster are often used interchangeably although each has a precise and distinct meaning. **Hazard**[1] is the broadest term and reflects a potential threat to

[1] Terms that appear in boldface can be found in the glossary.

humans as well as the impact of an event on society and the environment. **Risk** refers to the likelihood or probability of occurrence of an event. Hazards include risk (i.e., a probability), impact (or magnitude), and contextual (sociopolitical) elements. Quite simply, *hazards are threats to people and the things they value* (Cutter 1993). They are in part socially constructed by people's perceptions and their experiences. Moreover, people contribute to, exacerbate, and modify hazards. Thus, hazards can vary by culture, gender, race, socioeconomic status, and political structure as well. **Disasters**, in contrast to risks and hazards, are singular or interactive hazard events (like those mentioned in the first section) that have a profound impact on local people or places either in terms of injuries, property damages, loss of life, or environmental impacts. Finally, **vulnerability** is the potential for loss or the capacity to suffer harm from a hazard. The term, used in various ways by researchers, can generally be applied to individuals, society, or the environment.

## Types of Hazards

It is the interaction among nature, society, and technology that produces hazards, risks, and disasters, many of which may be amplified by global environmental changes currently underway. Hazards arise from many different sources (summarized in Table 1 below), and considerable research effort has focused on developing typologies of hazards to establish some order in an ever-increasing list of hazards (e.g., Hohenemser, Kates, Slovic 1985; Cutter 1993). Many of the typologies use the causes or origins of hazard events as the classifying principle. In most cases, however, hazards are multi-causal so that most researchers now refrain from proposing single cause-based typologies of hazards. Yet it is possible to classify hazards according to the area in which they *mainly* originate. Those originating from natural processes are referred to as **natural hazards**. Examples include **earthquakes**, **volcanic eruptions**, **floods**, **hurricanes**, **blizzards**, and **tornadoes**. These phenomena vary regionally and seasonally and may trigger **secondary hazards**. For example, **landslides** and **tsunamis** can follow earthquakes. **Thunderstorms** may be accompanied by heavy rains that can cause **mudflows**, **flash floods**, and conventional flooding. Hazards also arise from rather common natural events such as hail, coastal erosion, heat waves, and **droughts**, all of which can cause considerable damage to the natural environment and society.

Other hazards originate in social systems and include terrorism (domestic bombing such as the Oklahoma City incident as well as international acts of terrorism), **warfare**, **epidemics** (such as the Ebola virus), and civil disorder or ethnic violence (such as in Bosnia and Rwanda). The interaction of society, technology, and natural systems produces another type of hazard often called **technological hazards**. Nuclear power plant accidents such as the one at Chernobyl, industrial accidents like the one in Bhopal, oil spills, and hazardous materials spills all fall under in this category. Finally, there is a group of hazards that do not stem from one event but rather arise from more chronic conditions, including **famine**, **resource degradation**, **pollution**, and large-scale toxic contamination. These **chronic hazards** are the type that will be most affected by changes in the global environment. A broader term like **human-induced hazards** is

necessary to encompass the last two categories of hazards (technological and chronic types of dangers) and the above-mentioned hazards like warfare, terrorism, and epidemics.

**Table 1: Origins of Environmental Hazards**

| | |
|---|---|
| *I. Extreme Natural Events* | |
| Meteorological | |
| Hydrologic | drought, flash floods, conventional floods |
| Atmospheric | hurricanes, cyclones, tropical storms, tornadoes |
| Geophysical | |
| Seismic | earthquakes, tsunamis, volcanoes |
| Geomorphic | mass movements, landslides |
| *II. Common Natural Events* | |
| Meteorological | wind and dust storms, temperature extremes (heat waves, frost), severe summer storms (lightning, hail), winter storms, coastal erosion, drought |
| Geophysical | avalanches, soil subsidence, coastal erosion |
| Other | wildfires |
| *III. Biologic Agents* | |
| Epidemics | AIDS, influenza, cholera, ebola |
| Infestations | rabbits, termites, locusts, grasshoppers, bees |
| Other | recombinant DNA, bioengineering |
| *IV. Social Disruptions* | |
| Civil disorders | ethnic violence, riots, urban fires due to arson |
| Terrorism | local terrorism, global terrorism, bombings |
| Warfare | conventional war, chemical/biological weapons |
| *V. Technological Hazards* | |
| Extreme failures | nuclear accidents, industrial accidents, dam breaks |
| Common occurrences | power failures, radon, hazardous materials spills, oil spills, hazardous materials, transportation accidents |
| *VI. Chronic/Globally Catastrophic Hazards* | |
| Multiple types | pollution, environmental degradation, poverty, climate change, nuclear war, famine |

Source: Compiled by authors.

## Hazard Characteristics

The characteristics of hazards that enable us to compare hazards over time and space include magnitude, intensity, frequency, and duration. After all, we are not just interested in the type and

occurrence of hazardous events; we also want to know whether there are any systematic changes in their severity.

**Magnitude** describes the strength or force of an event. In order to assess the magnitude, one must first have a base line for comparison. In the case of floods for example, magnitude is often described as the maximum height of flood waters above average sea level, flood stage, or simply above ground. For seismic events, magnitude is measured on the **Richter scale** which is an estimate of the amount of energy released by an earthquake (see Table 2). But the strength of an event can also be measured by more than its physical characteristics. **Intensity** provides a useful measure of the severity of an event based on the subjective human experience of it. For example, the **Modified Mercalli scale** (see Table 3) measures the intensity of earthquakes based on damage to structures and the human experience of the event. For hurricanes, the **Saffir-Simpson scale** is a measure of both intensity and magnitude. It evaluates hurricane strength and impact based on a five-point scale with Category 5 hurricanes listed as the most severe and destructive (Table 4).

**Table 2: Richter Scale**

| *Richter Number** | *Energy Release* [in ergs] | *In Multiples of Base*** | *Mercalli Number* |
|---|---|---|---|
| 1-2 | $4.47 \times 10^{12}$ | 1-31.6 | I |
| 3 | $7.94 \times 10^{14}$ | 1,000 | II-III |
| 4 | $2.51 \times 10^{16}$ | 31,600 | IV-V |
| 5 | $7.94 \times 10^{17}$ | 1,000,000 | VI-VII |
| 6 | $2.51 \times 10^{19}$ | 31,600,000 | VIII |
| 7 | $7.94 \times 10^{20}$ | 1,000,000,000 | IX-X |
| 8 | $2.51 \times 10^{22}$ | 31,600,000,000 | XI-XII |

* The signals of seismic waves from which energy release is calculated can vary in strength by factors of 100 million. To accommodate this range, the Richter scale is logarithmic, i.e., the magnitude of an earthquake increases tenfold from one Richter number to the next (Skinner & Porter 1992:413).

** The energy release from one Richter magnitude to the next increases roughly 30 times (31.6 to be exact), thus the energy release from an earthquake with Richter magnitude 3 is 31.6 x 31.6 x 31.6 = ~1000 times bigger than the energy release of an earthquake with Richter magnitude 1, hence the multiplication factors in this column.

Source: Adapted from Burton, Kates, and White. 1993. *Environment as hazard*, 2nd edition.. Guilford Press, p. 37. © 1993 reprinted by permission of Guilford Press. I. Burton, R. Kates, and G. White.

## Table 3: Modified Mercalli Scale

| *Class* | *Intensity value and description* |
|---|---|
| I | Not felt except by a very few under exceptionally favorable circumstances. |
| II | Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. |
| III | Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing automobiles may rock slightly. Vibration like passing truck. Duration estimated. |
| IV | During day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing automobiles rocked noticeably. |
| V | Felt by nearly everyone, many awakened. Some dishes, windows and so on broken; cracked plaster in a few places; unstable objects overturned. Disturbance of trees, poles and other tall objects sometimes noticed. Pendulum clocks may stop. |
| VI | Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster and damaged chimneys. Damage slight. |
| VII | Everybody runs outdoors. Damage negligible in buildings of good design and construction; damage slight to moderate in well-built ordinary structures; some chimneys broken. Noticed by persons driving cars. |
| VIII | Damage slight in specially designed structures, considerable in ordinary substantial buildings with partial collapse, great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, walls, and monuments. |
| IX | Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; damage great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. |
| X | Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed, slopped over banks. |
| XI | Few, if any (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly. |
| XII | Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown into the air. |

Source: Adapted from Smith, K. 1992. *Environmental hazards: Assessing risk and reducing disaster*. Routledge, Appendix 1, p.296-297. ©1992 reprinted by permission of Routledge. *Environmental hazards: Assessing risk and reducing disaster*. Keith Smith.

## Table 4: Saffir-Simpson Hurricane Scale

This scale is used to give estimates of property damage and potential flood levels along the coast in the event of a hurricane.

| *Category* | *Description* |
|---|---|
| One | Winds 74-95 MPH or storm surge 4-5 feet above normal. Minimal damage to buildings. Damage to trees, shrubs, and unanchored mobile homes. Minor pier damage, coastal road flooding. |
| Two | Winds 96-110 MPH or storm surge 6-8 feet above normal. Some roof, door, and window damage to buildings. Damage to vegetation, mobile homes, and piers. Boats break loose from moorings. Coastal escape routes are flooded. |
| Three | Winds 111-130 MPH or storm surge 9-12 feet above normal. Structural damage to homes and utility buildings. Mobile homes destroyed. Coastal flooding destroys small structures; floating debris damages large structures. Land lower than 5 feet ASL (above sea level) may be flooded inland 8 miles or more. |
| Four | Winds 131-155 MPH or storm surge 13-18 feet above normal. Extensive infrastructural damage to homes and buildings. Roofs collapse or are blown off. Major erosion of beaches. Major damage to lower levels of structures near the coast. Land lower than 10 feet ASL is flooded. Massive evacuation of residents 6 miles inland. |
| Five | Winds greater than 155 MPH or storm surge greater than 18 feet above normal. Total roof failure on industrial buildings and homes. Some buildings completely collapsed. Major damage to lower floors of all structures less than 15 feet ASL. Massive evacuation of residents on low ground within 10 miles of the shoreline. |

Source: Derived and adapted from Alexander 1993, and Smith 1992, p. 182.

**Frequency** describes how often an event of a given magnitude or intensity occurs. This can be given in qualitative terms such as "frequent" or "rare," or in more quantitative estimates such as recurrence intervals. For floods, a recurrence interval of 10 years suggests that in any year, a flood of that magnitude has a 1 in 10 (10%) chance of occurring. **Duration** is another temporal dimension that describes how long an event persists. This can range from periods as short as several minutes to periods as long as decades or more.

**Speed or rate of onset** refers to the length of time between the first appearance of the event and its peak. We can think of rapid onset events such as tornadoes and nuclear power plant accidents or slow onset hazards such as soil erosion, pollution, or drought. The speed of onset is a characteristic of a hazard that is crucial in our efforts to avoid some of the worst impacts of

hazards. In other words, much of modern hazard management effort is geared toward improving our ability to detect signs of an impending hazard event as early as possible so as to expand the time between signal detection and the peak of the event for warning and possibly evacuating vulnerable populations.

**Temporal spacing** describes the sequencing and seasonality of events. Some hazards are quite random in their timing (industrial accidents, volcanic eruptions), whereas other hazards have a seasonal or regular periodicity (tornadoes, hurricanes). The implications of temporal spacing for hazard management are quite clear; if you can expect certain hazards to be more likely in certain seasons or at relatively regular intervals, you can be ready to communicate the risk to potentially affected populations in a timely manner, and mount the necessary efforts to allow you to respond more quickly and effectively to an emergency. Hurricane Bertha in July 1996 serves as a good example. After much criticism of the delayed federal response to Hurricane Andrew, the federal government issued a Presidential statement before Bertha's landfall that the emergency response teams were in place and ready for whatever may come (National Public Radio, July 12, 1996). Randomly occurring hazards are much more challenging to emergency response agencies because they require a low level of preparedness at all times for the rare case that requires quick, efficient, and effective responses.

The next two characteristics of a hazard allow us to examine its geographic extent. **Areal extent** is a measure of the space covered by an event. Some hazards like a tornado or a small gasoline spill may have a small areal extent; others such as droughts or major nuclear accidents (like the one at Chernobyl in 1986), affect large geographic regions. **Spatial dispersion** refers to the distribution of hazards over the space in which they can occur. Spatial dispersion is a useful measure of the geography of hazards because it differentiates between hazards that occur within a particular region and those that are more widespread. For example, although tornadoes can occur just about anywhere in the US, they primarily occur in the "tornado belt" of the Central Plains from Texas to Nebraska.

A final hazard characteristic refers to the **nature of exposure**, which is an important concern in reducing risk and mitigating the impact of hazards. For example, is exposure voluntary or involuntary? With many environmental hazards, we have little control over whether or not we are exposed to them; we can neither control the weather nor stop earthquakes. On the other hand, we do have some degree of choice (voluntariness) about where we live (e.g., floodplains, coastal regions), what kind of food we eat (e.g., organically or commercially grown produce), or what types of activities we engage in (e.g., scuba diving, using drugs, or smoking) that directly affect our vulnerability to some hazards. Parts 1 and 2 of *Focus Issue 1* highlight issues of frequency, magnitude, and the nature of exposure for flood hazards and provide a concrete example from South Africa.

## Focus Issue 1 -- Part 1: Living on the Edge: Why on Earth in the Floodplain?

Very few places on earth are not vulnerable to floods, except for the highest mountain tops and under present climate conditions, huge expanses of deserts such as the Gobi or the Sahara. The areal extent of flooding events is often vast and some places experience prolonged durations that result in a heavy toll. An example of a flood that brought large financial losses is the 1993 flood in the Midwestern US; disastrous losses of life are periodically seen in China and other Southeast Asian countries. Flooding accounts for 40% of all natural disasters with more than one hundred deaths per event (Burton, Kates, and White 1993). This enormous toll is due to the extent and frequency of flooding, the fact that people live and work in areas prone to flooding, and inadequate warning of the approaching dangers. Given these facts, why do people continue to live in riverain and coastal areas bound to be flooded?

Floodplains are areas defined as most at risk from flooding, both riverain and coastal. The areal extent of the flood varies with the magnitude of storms, the rapidness of snowmelt, the height of the storm surge, and other geographic factors. Yet floodplains are also among the most attractive areas for human occupance; they are level, easy to build on, and they have very fertile soils. Coastal areas, in addition, offer access to, and sometimes a much desired view of, the ocean. In the United States, the federal government is most concerned with flooding in what is called the 100-year floodplain. The 100-year flood recurrence interval refers to a probability of at least 1% that an area will be flooded in any given year. This corresponds to the flood levels expected on the long-term average of once every one hundred years, hence the often misinterpreted term "100-year flood" (USGS 1995). It is important to note that only the outermost edges of the 100-year floodplain have a risk as low as 1% per year (Platt 1996). As one moves closer to the stream channel or tide line, the risk increases progressively. This kind of recurrence terminology, unfortunately, has the effect of making the flood hazard sound remote and not worthy of attention by those at risk. People think that they will be gone or not using the area anymore by the time the next flood event is expected to occur. This misunderstanding is cause for great concern.

To the engineers and hydrologists who delineate the 100-year floodplain, flooding events are random, meaning that the probability of their recurrence is the same each year (1 in 100 or 1%). For those at risk, however, there has been a demonstrated tendency to assume that a severe hazard occurrence such as a 100-year flood is followed by a period of lessened hazard activity (Burton, Kates, and White 1993). This partly explains why activity in and occupance of hazardous areas increases. Experience with the flood hazard is frequency-dependent and as such, new arrivals to the hazardous area may be less accurate in their judgement of the flooding risk. This is especially important with respect to the prospects of global change; flood frequencies and magnitudes might increase both because of changes in climate and rising sea levels and because of increasing numbers of people moving into flood-prone areas, rapid urbanization, and poverty.

The threat to life and property associated with flooding is expected to increase without intervention -- that is, even if climate will not change in the future. Appropriate intervention aimed at reducing disaster proneness must address population increases in the hazardous floodplain directly as well as upstream watershed management (e.g., farm management techniques to reduce filling up of stream channels with sediment) and the over-reliance on technology, structural protection measures, and insurance, all of which foster a false sense of safety behind levees and insurance policies. Living with nature, rather than over-engineering and conquering it, clearly calls for a new approach to floodplain management.

## Focus Issue 1 -- Part 2: Six Feet of Water Over the Desert Floor: South Africa

In 1981, the small town of Laingsburg in the Small Karoo in South Africa (an inland semi-desert area) experienced one of the worst floods in the history of the country. Along with a mortality level unprecedented in South Africa for flood events, the flood changed the natural and urban landscape of the affected area beyond imagination.

Like that of many towns in the Karoo, the pre-flood urban landscape of Laingsburg was characterized by older houses and municipal buildings with charming styles of architecture dating back to earlier times. Most of these were destroyed in the disastrous flood, fundamentally altering the character of the town. Moreover, the flood significantly changed the natural course of the Buffels River causing changes in town lay-out and zoning in its wake.

The flood was an extraordinary event in many respects. First, the weather patterns at the time were highly unusual. In the winter, the southern part of the country is commonly affected by low pressure systems that move from the south-west and bring cold fronts. Usually the fronts don't have much effect on the Small Karoo in terms of significant rainfall (it is, after all a semi-arid area), or the effects are very short-lived as the fronts pass over swiftly. On this occasion, however, the atmospheric circulation over the subcontinent gave rise to a condition known as a "cut-off low" or a low pressure system that is effectively "anchored" in place by the way neighboring pressure systems are positioned over one area. This almost stationary low gave rise to very high volumes of rainfall over a larger area including Laingsburg -- rainfall that also persisted for an unusual amount of time.

Second, and unsurprisingly, people did not expect and were unprepared for the suddenness and volume of the flood. Given the low expectancy of floods in the semi-arid area, many houses, shops, and even a senior citizens' home had been built along the banks of the river. During the event, as the flood waters began to rise, curious passers-by came down to the banks to watch the exciting event. Cars traveling on the nearby main highway that connects Johannesburg and Cape Town (the N1) slowed or stopped to see the rushing waters. According to eyewitnesses, several vehicles had pulled over on the bridge crossing the Buffels River itself to watch in fascination. As the first torrent of water roared down the river bed, part of the bridge and the occupants of the vehicles on it were swept away. There were other tragedies and instances of heroism; as the water rose, residents of the old age home who were able climbed onto the roof of their building but were unable to escape. A married couple was swept downstream as they attempted to save other victims, but both were strong enough swimmers to be able to swim ashore and escape dangerous debris.

A third aspect makes this flood unusual: the patterns of destruction affected not the poorest people of town (as is often the case given typical socioeconomics of floodplain occupation), but the better-off. Buildings near the river were largely owned and occupied by higher-income, white people in a town that at the time was still segregated by apartheid. Ironically, the flood devastated these areas and left the poorer townships on the hillside and on higher ground mostly untouched.

Today, the town has been rebuilt although without its former charm. Travelers on the N1, some of whom knew the town before the flood, drive through the center of the small town to find a sign in the middle of the main street that indicates the flood level. It stands at well over 6 feet tall in the desert landscape.

*QUESTIONS:*

- If you knew someone who was about to move into an area delineated as a floodplain, what would you say to this person?
- Why are flood losses (lives and property) increasing and what can be done to stop this trend?

## The Role of Geography in Hazard and Global Change Research

At the beginning of this unit, we posed five questions that we will address in this module:

1. Are societies becoming more vulnerable to environmental hazards and disasters? If so, which hazards may intensify in the future as a consequence of global environmental changes?
2. What social/physical factors influence changes in human occupance of hazard zones?
3. How do people respond to environmental hazards and what accounts for differential adjustments (in the short term) and adaptation (in the longer term)?
4. How do societies mitigate the risk of environmental hazards and prepare for future disasters?
5. How do local risks and hazards become the driving forces behind global environmental changes?

A number of factors prohibit simple answers to these questions. First, as we demonstrated above our perceptions and conceptualizations of hazards have changed over time. We no longer think of hazards as singular, purely natural events (as in "acts of God") or as purely technical disasters (brought about by "human fault or failure") but rather as more complex phenomena involving the interaction of natural, social, and technological systems. Thus, hazard typologies based only on the origin of events in the geophysical or the technological realms are no longer tenable; neither is the resulting distinction between purely natural and purely technological hazards. Second, we now think of impacts of, and responses to, hazards as embedded in our social and environmental systems. It is increasingly difficult, if not impossible, to separate the impacts of specific disasters or hazards from broader social and environmental issues. As a consequence, hazard management systems have become more complex and politicized as the range of management alternatives has expanded to include not only geotechnically expedient "solutions" but also options that require decisions made on the basis of social choices (Mitchell 1990; Kates 1985).

These developments in the hazards field have been influenced by and have helped to shape the global environmental change research agenda. For example, research has focused on the difficulty of discerning natural versus human shares in causing global changes, the heavily politicized and ethically loaded debate over how to mitigate the impacts of global change, the role of technology in causing and responding to global change, and the economic challenges and social choices we face in responding to global changes. The hazard research agenda has been extended to include large-scale, regional-to-global, slow-onset, and cumulative hazards in response to the needs of the global change research community (Burton, Kates and White 1993; Mitchell 1989). Likewise, the global change community has borrowed impact assessment methodologies, notions of risk and uncertainty, and other concepts and approaches from hazards research to address global problems.

In addressing these complex questions, geography can play a pivotal role. Both the hazards and global change fields have traditionally been interdisciplinary and in the last few years,

geographers have become increasingly involved. Geographic scale is crucial to understanding hazards distribution, impact, and reduction (Cutter 1994). The discovery of new hazards and the rediscovery of older ones with more dispersed and cumulative impacts necessitate the globalization of risk and hazard management systems. Unfortunately, because of the enormous difficulties of conducting truly global studies, much hazard research continues to be in the form of local or regional case studies. The articulation between local and global processes will continue to challenge geographers and other researchers.

Geographers also contribute their expertise on the linkages among physical processes and human contexts. This helps us to understand better the causal mechanisms that bring about hazards and disasters, and is of great importance to hazard management. This expertise also helps define the areal extent of the hazard, one of the important characteristics of hazards.

In summary, many linkages exist between hazards and global environmental change research, and geographers have much to contribute. In fact, geographers with expertise in environment-society interactions at different scales, an interest in historical and future trends, and a keen awareness of the ways in which different societies perceive these relations are situated at the intersection of hazards and global change research.

# 1 What Are Environmental Hazards?

## Instructor's Guide to Activities

### Goal

The activities in this unit are intended to (1) introduce the subject matter of hazards in the context of global change, and (2) heighten students' awareness of the importance of hazard perception and experience as a crucial factor in hazards research and hazards management.

### Learning Outcomes

After completing the activities associated with this unit, students should:

- understand that the term "hazard" does not lend itself to a simple, standardized definition;
- have a sense of the importance of hazard perception and the (albeit inconsistent) differences in risk perception between different genders, ethnic groups, etc.;
- know where regionally certain hazards are more likely to occur;
- understand that hazard impacts vary with location because of natural, technological, and social systems;
- be able to use the Internet/WWW as a research tool;
- know how to design, administer, and qualitatively analyze a simple survey.

### Choice of Activities

It is neither necessary nor feasible in most cases to complete all activities in each unit. Select those that are most appropriate for your classroom setting and that cover a range of activity types, skills, genres of reading materials, writing assignments, and other activity outcomes. This unit contains the following activities:

| | |
|---|---|
| 1.1 My Very Own Disaster | -- Story telling in small groups and discussion with the entire class |
| 1.2 Delineating the Hazards of Place | -- Web search, mapping, and creation of national hazard profiles |
| 1.3 Six Myths of Hazards | -- Critical text reading and news media analysis |
| 1.4 Differences in Hazard Perception | -- Survey of local community residents on their risk perception |

### Suggested Readings

The following readings accompany the activities for this unit. Choose those readings most appropriate for the activities you select and those most adequate for the skill level of your students.

- Unit 1: What are Environmental Hazards? (provided)
  The background information to Unit 1 that all students should read.
- Jones, David. 1993. Environmental hazards in the 1990s: Problems, paradigms and prospects. *Geography* 78, 2: 161-165. (provided)
  This article accompanies Activity 1.3. It is accessible and easy to read. It can also be used as a general background reading to Unit 1 as it reflects on contemporary hazards research in general before it highlights the pervasive misconceptions about hazards.
- Namafe, Charles and Frances Slater. 1995. Floods: Friends or enemies? *Geographical Education* 8, 3: 57-62.
  An interesting article that questions the common yet culturally specific notion of floods as hazards (i.e., as enemies) by comparing the Dutch ways of managing flood hazards with the Zambian view of floods (and by extension, the Zambian perception of Dutch intervention in Zambia).
- Mitchell, James K. 1989. Hazards Research. In: *Geography in America*, ed. , 410-424.
  *Geography in America* encompasses accessible overview articles of American research directions in geographic subdisciplines and related areas of interests. A good article to frame the module as a whole.
- Greenberg, Michael and Dona Schneider. 1995. Gender differences in risk perception: Effects differ in stressed vs. non-stressed environments. *Risk Analysis* 15, 4: 503-511.
  One of the suggested readings for Activity 1.4. The study finds that there are consistent differences between men and women in non-stressed environments, but non-consistent differences in behavior among the two genders in stressed environments. A good preparation for the survey students are asked to conduct.
- Flynn, James, Paul Slovic, and C.K. Mertz. 1994. *Gender, race, and perception of environmental risks*. Eugene, OR: Decision Research (provided).
  This study (also for Activity 1.4) analyzes risk perception through all possible combinations of gender (male/female), race (white/African American), and culture. It finds a fairly consistent difference between (1) males and females from Europe and Canada and females from the US and (2) white males from the US in how hazards are viewed. Power, status, alienation, and trust are offered as explanations for the findings, but the study opens up many new questions. Point students especially to Figures 1-4. (See studies by Elaine Vaughn on Hispanic farm workers for more sophisticated research of cultural aspects.)
- Cutter, Susan. forthcoming. Environmental disasters. In: *The Women's Studies encyclopedia*, eds. C. Karmaraw and D. Spender. New York: Wheatsheaf.
  This general statement is useful as it discusses briefly the gender differences in how environmental hazards are defined and perceived.

## Activity 1.1 My Very Own Disaster

### Goals

This activity is designed to introduce the subject of hazards to students. It has three interrelated goals: (1) to help students recall pre-existing knowledge about hazards; (2) to demonstrate to students why this subject is important and relevant to them; and (3) to give students the opportunity to see how people define and experience hazards differently.

### Skills

- ✔ recalling memory
- ✔ story telling in a clear and interesting way
- ✔ critical thinking and non-judgmental listening

### Material Requirements

- *Student Worksheet 1.1* (provided)
- *Supporting Material 1.1* (optional; provided)

### Time Requirements

25 minutes

### Tasks

This is a starter activity, meant to stimulate students to think about hazards, to connect with the subject matter personally, and to provoke interest in the subject. It works well even before students have read anything about hazards.

Ask students to jot down any experience they (or a relative or close friend) have had with a "hazard." Do not give them a definition of a hazard and do not narrow their choices by giving examples. Thus, students will define for themselves what they think is a hazard. You may prompt them with the following questions or statements:

- What is the most dangerous thing you ever did?
- Think about the most hazardous experience you ever had.
- Can you remember a time when you felt that you were in a lot of danger?

After 5 minutes each student gets an opportunity to relate briefly his or her hazard story to the class, and others have the chance to ask questions. If your class is large, split the class into smaller groups of 4-5 students for the "tell-and-ask" period. As people tell their stories, pick an example of a "hazard" (for example, a severe snowstorm) and, after one student has related her/his experience, ask the other students about experiences they have had with the same type of "hazard." Invariably, someone will say that they had a great time with snowball fights, skiing, or sledding. If no one volunteers such radically alternative views, make up one yourself -- the next time, students will feel freer to relate alternative experiences.

After going through a number of examples like this with all kinds of experiences, remind students that you started this activity out by asking them to recall a **hazardous** experience and that there have been a variety of responses. Ask students "So what is a hazard?" -- a question that may be met with a confused silence. Tell them that the silence is the correct answer; there is **no one** answer to what a "hazard" is. From here you may introduce the module content, or discuss with the class implications of differing hazard perceptions and experiences for measuring trends, for hazard management, and so on.

## Activity 1.2 Delineating the Hazards of Places

### Goal

By developing a hazard profile of a particular country, students learn that there are extensive geographic variations in the occurrence and impacts of hazards at both the regional and global scales.

### Skills

- ✔ "Web surfing" (becoming familiar with the available Internet-search software, data search, evaluation of search results, distilling relevant information)
- ✔ creating an interesting hazard portfolio for a chosen country (incl. graphs, tables, and text)
- ✔ report writing

### Material Requirements

- *Student Worksheet 1.2* (provided)
- *Supporting Material 1.2* (optional; provided)
- Appendix A: Selected Internet/WWW Hazards Sites (provided)
- A large, class-size world map (alternatively, an overhead of a world map)
- Colored push-pins (alternatively, color pens for overheads)
- Computer terminals with access to Internet/WWW (assigning students to small groups will reduce the necessity for many computers)

### Time Requirements

1 week of outside of class for preparation of country hazards profiles
1 full class period (50 minutes) for presentations and world hazard map generation

### Tasks

This is a computer-based activity involving the Internet and the World Wide Web. Students will gain insight into the variety of hazards that a chosen country faces. Depending on this country's location in terms of geophysical hazards, its state of development, and its economic and technological activities, a specific hazards profile will emerge. Comparing different countries' hazard profiles will reveal commonalities and idiosyncrasies.

This activity should be done in small groups of 3-4 students. You can let students form groups and quickly decide on a country, or you may already have chosen a number of countries that students can form groups around according to their regional interests. Make sure various parts of the world are represented (i.e., first, second and third world countries; low-, mid-, and high-latitude countries).

Students look for the data on their country in some of the on-line sources provided in *Appendix A: Selected Internet/WWW Hazards Sites*. For those students new to the World Wide Web, or to generally facilitate the entry into the cyber-world of hazards, you may want to recommend the hazard site of the *Virtual Library* as a starting point (http://life.csu.edu.au/hazards/library.html). At this site, students will have a choice of hazard topics to choose from (see *Supporting Material 1.2*) and links to other relevant sites are available. This entry point is particularly helpful if students already have an idea of what types of hazard to expect in their chosen country. Encourage students to explore additional web sites that might be pertinent to developing their country's hazards profile. Some countries are more affected by natural hazards than others. Still other countries are more susceptible to technological failures.

If students do not know which hazards to expect in any one country, they may begin their search from one of the global overview sites, e.g., *The Global Earthquake Report* (http://geovax.ed.ac.uk/quakexe/quakes); the *Pan American Health Organization* (http://www.paho.org/), the *World Health Organization* (http://www.who.ch/); *Red Cross/Red Crescent* (http://www.ifrc.org); the *Global Flood Monitoring and Analysis Project*'s site (http://www.dartmouth.edu/artsci/geog/floods/Index.html), the *International Decade for Natural Disaster Reduction* site (http://hoshi.cic.sfu.ca/~hazard/idndr.html); or the *Natural Hazards Center at University of Colorado in Boulder* (http://adder.colorado.edu/~hazctr/Home.html).

It is a good idea to check and verify the Internet sites prior to assigning this activity because Internet and Web addresses are subject to change.

For ease in conducting the analysis, students should focus only on specific disaster events as reported to disaster and relief agencies, rather than the chronic hazards problems that almost all nations face, such as water and air pollution (unless this is a prominent issue in their chosen country), or driving and aviation hazards.

Ask students to prepare a short report (a few paragraphs) on the hazardousness of their assigned country to present to the class (no more than 5-7 minutes for each presentation). The parameters they should examine include but are not limited to the following:

1. type of disaster
2. frequency, magnitude, duration of event
3. location
4. impact (deaths, injuries, property damage)
5. trends over time and over space

Their report should include disaster statistics for the above parameters. A chart is an excellent way to present some of this information. Two examples are given in the *Answer to Activities* for Unit 1. Students should also present any background information on their country regarding its ability to respond to and recover from these disastrous events. To that end, you should brainstorm with the class before assigning the activity about what factors limit the ability to respond to and recover from hazards (e.g., poverty).

The whole class will participate in creating a global hazard map with the information gathered in these reports. Each student or group will use colored tacks to display the location of their hazards on the map. Alternatively, place dots with color pens on an overhead map (this may be easier but is not as readily available for future reference while working with this module). Use a different color for each type of hazard (i.e., red for earthquakes, blue for floods, etc.). When all countries have been marked on this map, ask students to summarize the geographic variation of hazards, indicating which countries have which types of hazards in common and why this may be so.

This activity may also be assigned to students individually, in which case you may ask them to submit a short paper (5-7 pages) including tables of disaster statistics, graphs that plot the number of disasters over time, and a dot map showing the location of each event.

## Activity 1.3 Five Myths About Hazards

### Goals

Students read a critical approach to hazards representation in the media and elsewhere and apply this approach in their own analysis of news media articles on hazards.

### Skills

✔ critical analysis of news media
✔ application of general, abstract myths to specific, concrete text passages
✔ clear class presentation of findings

### Material Requirements

- *Student Worksheet 1.3* (provided)
- Suggested reading: Jones (1993) (provided)

### Time Requirements

1 week of out-of class preparation (preparatory reading, news search, analysis, and preparation of short in-class presentation)

### Tasks

One week before this activity, ask students to select two newspaper or magazine articles -- one reporting on a hazard event within the US and one reporting on a hazard event outside the US.

Students should also read the suggested reading (Jones 1993) that highlights the five misconceptions concerning hazards which are usually apparent in the way they are represented in the media (the five myths or misconceptions are clearly listed in the article).

Using the articles they find, students prepare a two-page summary in which they

- summarize the hazard they focused on;
- show how each article demonstrates the ways of thinking about hazards that are mentioned in the suggested reading (Jones 1993); and
- compare and contrast how the stories of the hazard events are told to the reader.

During the designated class period, ask several students to present their findings to the class and to provide examples of each of the myths that they found. Students who do not present in class should hand in their analysis and discussions in written form (no more than 2-3 pages). Conclude the presentations with a debriefing discussion and summary.

## Activity 1.4 Differences in Hazard Perception

### Goals

Students examine variations in risk perception by surveying community residents in an area of environmental stress. Students consider whether their results support published findings on the importance of gender, ethnicity, and place to the perception of risks.

### Skills

- ✔ critical text comprehension
- ✔ development of simple survey questions
- ✔ administering of survey to local community residents
- ✔ analysis of data (quantitative analysis optional)
- ✔ writing a research report

### Material Requirements

- *Student Worksheet 1.4* (provided)
- Suggested readings: Greenberg and Schneider (1995)
  Flynn et al. (1994) (provided)

### Time Requirements

2 weeks

### Tasks

Students examine whether there are any gender, ethnicity, and place-based differences in the perception of environmental risks. The existing literature provides mixed results, as the two suggested readings illustrate. Ask students to read these articles and critically assess the

differences in methodologies and results. They also should note (or be made aware of) the lack of discussion about place in reporting and explaining the results of these studies.

Once students are familiar with the strengths and weaknesses of these two studies, they should begin to design their own survey. The goal of their survey is to discern whether there are differences in how women, men, whites, people of color, and different cultural groups in different places in their town perceive environmental hazards. You may pick several neighborhoods beforehand (e.g., inner city, new suburbs, older suburbs) preferably with known hazards in them. If these neighborhoods are not ethnically mixed, try to find some that are or suggest neighborhoods that face similar hazards but differ demographically.

Geographers have conducted various types of surveys, but we recommend a five-point Likert scale. The number of survey items should be limited to no more than 15 or 20. Ideas for the survey items can be taken, but should not be limited to, those used in the above-mentioned studies. As this is likely to be the first opportunity for your students to do a survey, help them formulate the survey questions so that they are easy to answer, clear, unambiguous, polite, respectful, and interesting. Ask students to pair up and prepare a list of survey questions and hand them in for evaluation and suggestions before they begin the survey. Also ask them to formulate five hypotheses prior to starting their field work.

In their paper, students should report what differences they found in risk perception and how they can be explained. Students should use social, demographic, economic, and political background information about the neighborhoods they survey to support their conclusions. This may include locational specifics such as average level of education, population changes, housing policies, income variations, employment, quality of life measures, etc. Ask students also to analyze their findings with respect to the hypotheses they proposed earlier. The report should be no longer than five pages (one report per pair of survey interviewers) and should include tables and graphics, and possibly maps. Students can receive extra credit if they perform statistical analyses and/or prepare maps using GIS.

Note: This activity may require approval for research involving human subjects from your college/university. Please make sure to comply with these requirements.

# 1 What Are Environmental Hazards?

## Student Worksheet 1.1

### Activity 1.1 My Very Own Disaster

Take a pen and paper and jot down a hazards experience you have had. Alternatively, this could be something that a relative or close friend of yours has experienced. Don't worry about whether it's the "right kind of hazard" you should be thinking about. The important thing is that you think it was a hazardous event and that you can recall it well enough to describe it in some detail. What happened? How did you (or the other person who was in that situation) feel about it? What did you do in that situation?

Then get together in groups of four or five and take turns relating your experiences to each other. When others tell their experiences, you can ask questions if you need to, but remember to respect your classmates' experiences as their own.

As you listen to other people's stories, try to remember whether you have had a similar experience. Were your experiences similar or did you feel quite differently about the situation? How so?

Look for the commonalities and differences in the stories you hear. If you were asked to define what a "hazard" is after all you have heard, what would you say? You will discuss this further in class.

# Student Worksheet 1.2

**Activity 1.2 Delineating the Hazards of Places**

There are extensive geographic variations in the occurrence and impact of hazards at both the regional and global scales. This activity will facilitate your understanding of these spatial variations by developing the **hazardscape** of a particular country. A hazardscape is the landscape of all hazards in a particular place. The interaction among nature, society, and technology at a variety of spatial scales creates a mosaic of risks that affects places and the people who live there. Some countries are more affected by natural hazards than others. Still other countries are more susceptible to technological hazards. For ease in conducting the analysis, you will only focus on specific disaster events as reported to disaster and relief agencies, rather than the chronic hazards problems that all nations face.

You will work on this activity in small groups of 3-4. You will either choose a country or be assigned one by your instructor. Compile data on disaster events in your assigned country during the last 10-20 years from Internet and World Wide Web sources. You will be able to find your data in some of the on-line sources listed in *Appendix A: Selected Internet/WWW Hazards Sites*. If you are already familiar with how to "Web surf," and if you have some basic ideas of what hazards to expect in the country you are working on, begin your search at the hazard site of the *Virtual Library* which you can find at the following address:

http://life.csu.edu.au/hazards/library.html

From the various information sources listed in the *Virtual Library* for each type of hazard, you can easily connect to other Web sites. In addition, use the Web sites listed in the Appendix and explore any other relevant additional Web sites that you come across to help you develop your country hazard's profile.

If you are not familiar with "Web surfing," team up with one of your classmates who has already worked on the Web for a basic introduction to Internet searches. You will pick up on it very quickly as you practice during this activity. If you are not sure what hazards to expect for your particular country, go to the following Web sites for some leads:

| | |
|---|---|
| *The Global Earthquake Report* | http://geovax.ed.ac.uk/quakexe/quakes |
| *Pan American Health Organization* | http://www.paho.org/ |
| *World Health Organization* | http://www.who.ch/ |
| *Red Cross/Red Crescent* | http://www.ifrc.org |
| *Global Flood Monitoring and Analysis Project*'s | http://www.dartmouth.edu/artsci/geog/floods/Index.html |

| | |
|---|---|
| *Internat. Decade for Natural Disaster Reduction* | http://hoshi.cic.sfu.ca/~hazard/idndr.html |
| *Natural Hazards Center at Univ. of CO, Boulder* | http://adder.colorado.edu/~hazctr/Home.html |
| *Hazards Research Lab, Univ. of South Carolina* | http://www.cla.sc.edu/geog/hrl |

**Try not to get lost in the wealth of information "out there."** It happens easily! In fact, you will be looking for very specific information, including (but not limited to) the following:

1. type of disaster
2. frequency, magnitude, duration of event
3. location
4. impact (deaths, injuries, property damage)
5. trends over time and over space.

After you've gathered a sufficient amount of information, prepare a short report (a few paragraphs) on the hazardousness of your country. Your report should include disaster statistics in table and graph format for the above parameters (it's always helpful to have overheads or hand-outs for your classmates). Include some background information on your country regarding its ability to respond to and recover from these disastrous events. Your group should be prepared to present its findings to the class.

In class, all of you will participate in creating a global hazard map from the information gathered in your reports. Take notes for yourself while you discuss the results in class as to some of the commonalities and differences that exist among nations in terms of the hazards they face.

# Student Worksheet 1.3

**Activity 1.3 Five Myths About Hazards**

Read carefully the article provided by your instructor (Jones 1993). Over the course of a week, choose two newspaper or magazine articles, one reporting on a hazard occurring within the United States and one occurring outside of the United States if you can find one. You may choose articles on the same type of hazard or different ones. In the unlikely event that nothing hazardous happens in the particular week you are working on this activity, go through past weeks' newspapers and journals.

Prepare a two-page summary or, if you present your results to the class, a brief presentation (maximum one overhead sheet to guide you along your presentation) in which you

1. summarize in no more than three sentences the hazards you focus on;
2. show how each article demonstrates the ways of thinking about hazards that Jones mentions (you may want to give a good example of each type of myth you believe is represented in your chosen articles); and
3. compare and contrast how the stories of these hazard events are told to the reader in the light of your assessment in (2.). What impressions are provoked of the event and of the people affected by it? Which of the myths are used to bring about this impression?

# Student Worksheet 1.4

**Activity 1.4 Differences in Hazard Perception**

In this activity you will examine whether there are any gender, ethnicity, and place-based differences in the perception of environmental risks. The existing literature provides mixed results, as the two suggested readings illustrate. Begin by reading the two studies suggested by your instructor and critically assess the differences in methodologies and results. Is there anything you feel is missing from the report and the explanation of the results in these studies? What do you think are the strengths and weaknesses of these studies?

Your task in this activity is to design and conduct a survey on risk perception. The goal of the survey is to discern whether there are differences in how women and men, different cultural groups, whites and people of color, and people in different places in your town perceive environmental hazards. Your instructor will offer you a number of neighborhoods to survey which may include the inner city, new suburbs, and older suburbs, preferably some with known hazards in them. They may or may not be ethnically mixed. In order to find out whether there are differences, you and one other student will survey individuals living in areas with some sort of environmental stress, e.g., in floodplains, near toxic waste dumps, and so on.

You and your partner will develop questions that ask people to respond on a scale from 1-5 (known as a Likert scale). With your partner, prepare a list of survey questions and formulate five hypotheses about what you expect to find. The number of survey items should be limited to no more than 15 or 20. To get some ideas of the kind of survey items you could use, look over, but don't limit yourself to, those used in the above mentioned studies (especially Greenberg and Schneider's Tables 1 and 2). Your instructor will help you formulate the survey questions, but give it a good shot yourself. Survey questions should be easy to answer, clear, unambiguous, polite, respectful, and interesting.

Give the survey questions and the hypotheses to your instructor for evaluation and suggestions before you conduct the survey. Take turns with your partner asking people questions so that you both get some practice. Remember to be polite even if someone doesn't want to answer your questions.

After you have completed your surveys, analyze your data to see if differences exist in risk perception among the various groups of people. If you are familiar with some of the statistical procedures to analyze data, go ahead and do that, but it is not necessary for this activity. Even for non-statistical analyses, however, you have to organize your survey answers. Below are some suggestions on how to do that:

Take a blank copy of your survey and note the summary results for each question.

- For a **breakdown by gender or ethnicity**: count the number of males, females, whites, people of color (by ethnicity) and write the totals for each category next to the place on the survey where you marked that type of information;
- For a **breakdown by gender/ethnicity combinations**: you may also count how many white males, white females, African American males etc. you had and write those figures down;
- For a **summary overview of hazard perceptions**: for each further question, count how many people answered with each number on the Likert scale, e.g., how many answered that they are "very concerned" (= 5) about the toxic waste dump in their neighborhood? -- write down that total;
- For a **breakdown of hazard perceptions by gender, ethnicity and gender/ethnicity combinations**: count how many women, men, white people, people of color and people with any combination of those characteristics answered your survey questions in a particular way; e.g., how many African American males answered that they are "not at all concerned" (= 1) about lead in paint? -- write down that total.

Complex analyses like the latter where you look at several variables at the same time may be easiest to show in form of a table like the one below. All you need to do is fill in the totals.

**Degree of Concern over Local Waste Dump by Gender and Ethnicity (Mytown, Nowhere)**

| | Males | | Females | |
|---|---|---|---|---|
| | Whites | Non-Whites | Whites | Non-Whites |
| Not at all concerned (1) | | | | |
| Little concerned (2) | | | | |
| Concerned (3) | | | | |
| Very concerned (4) | | | | |
| Don't know (5) | | | | |

With your partner, analyze your findings with respect to the hypotheses you proposed earlier and describe your findings in a 5-page report. If you find differences in risk perception, report what they are and how they can be explained. Support these conclusions using social, demographic, economic, and political information about the neighborhoods that you surveyed. This may include data on average level of education, population changes, housing policies, income variations, employment, quality of life measures, etc. Include tables and graphics, and even maps.

# 1 What Are Environmental Hazards?

## Answers to Activities

### Activity 1.1 My Very Own Disaster

Students should relate their experience or that of a close relative or acquaintance clearly and interestingly and should finish the activity having gained an awareness of the following main points:

- hazards are phenomena that affect all of us, frequently in physical or metaphysical areas close to home;
- different people may experience the same or similar hazard event in different ways;
- what are hazards in one region may not be perceived as hazards elsewhere (see *Supporting Material 1.1* for a personal account of a snow storm in Texas that makes this point well).

### Activity 1.2 Delineating the Hazards of Places

The results of this activity depend on the countries chosen, the amount of information students are able to find, and their individual creativity and diligence. In evaluating students' reports, assess the following aspects of their presentation:

- clarity of presentation (tables and charts constructed, visuals, speech)
- diversity of information included
- number of Web sites used
- overall informational content of the hazard profile
- inclusion of appropriate contextual information regarding the ability to respond to hazards

Below is an example of a hazardscape of one country, Indonesia.

**Indonesian Hazardscape**

Located in Southeast Asia, Indonesia is an archipelago of over 13,000 islands, 6,000 of which are inhabited. Indonesia's location near the Equator places it along major sea lanes between the Indian and Pacific Oceans. The total land area is about 1.8 million sq. kilometers with over 54,000 km of coastline. The population is estimated to be about 203.5 million with a growth rate of 1.5%.

Current environmental issues include deforestation, water pollution from industrial wastes, sewage, and air pollution in urban areas. Natural hazards include floods, droughts, tsunamis, earthquakes, landslides, and volcanoes. Human health hazards include exposure to hepatitis B, Japanese encephalitis, typhoid, rabies, cholera, and malaria in rural areas.

Indonesia is party to numerous international agreements concerning biodiversity, climate change, endangered species, hazardous wastes, the law of the sea, nuclear test bans, ozone layer protection, ship pollution, tropical timber, and wetlands. Japan supplies most of Indonesia's disaster and economic aid.

Disaster statistics and background information on the country can be obtained by conducting a Web search on Indonesia (e.g., at the following site: http://www.polrisk.com/ where you select Indonesia and go through the fact sheet, the geography section and so on). Then check any of the hazard-related Web sites on specific information. For very good information on Indonesian volcanoes, for instance, go to the Volcano World web site at the University of North Dakota (http://volcano.und.nodak.edu), ready with narratives, updated disaster statistics, satellite imagery, photographs, and so on. From this site comes the table shown below. The amount of information for some countries is enormous!

**The Deadliest Eruptions in Indonesia**
**(Eruptions with > 500 known human fatalities)***

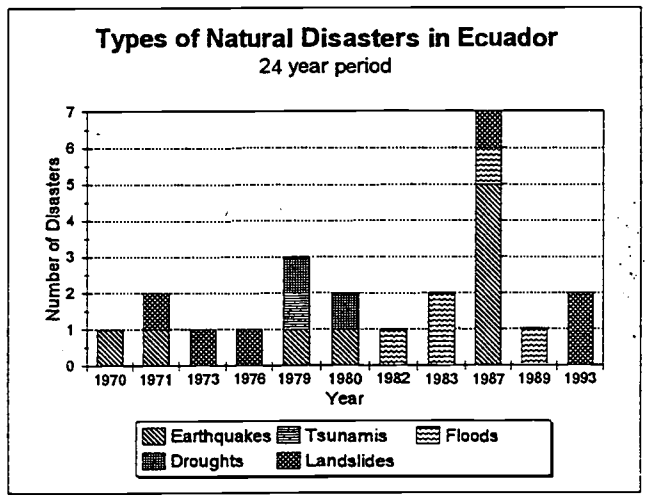
| Deaths | Volcano | Date | Major Cause of Death |
|---|---|---|---|
| 92,000 | Tamborra | 1815 | Starvation |
| 36,417 | Krakatau | 1883 | Tsunami |
| 5,110 | Kelut | 1919 | Mudflows |
| 4,011 | Galunggung | 1882 | Mudflows |
| 2,957 | Papandayan | 1772 | Ash flows |
| 1,184 | Agung | 1963 | Ash flows |

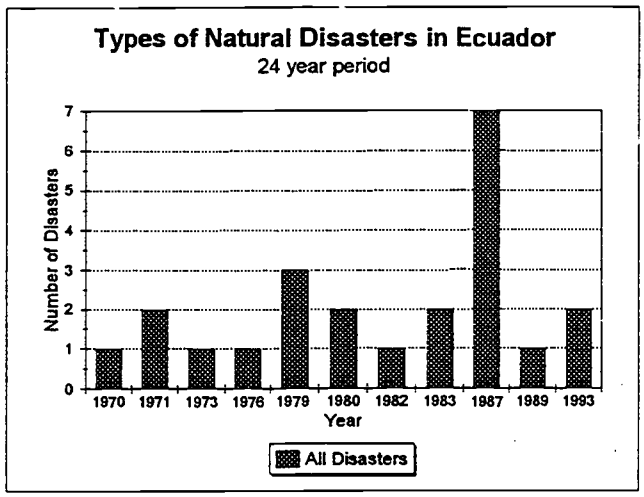
* Does not include major eruption in the 16th century or the Merapi eruption in 1994 for which fatalities are either not known or not >500 people.

Source: extracted from a table ("The deadliest eruptions") at the *Volcano World* Web site (http://volcano.und.nodak.edu) for South East Asia, June 1996.

From the World Health Organization and the Centers for Disease Control and Prevention, information is available on the health risks of Indonesia including a description of preventive measures.

Below are two examples of charting disaster statistics for a different country, Ecuador.



## Activity 1.3 Five Myths About Hazards

The following myths or misconceptions are described in greater detail in Jones (1993):

1. tendency to focus on conspicuous, dramatic, high-energy events of questionable regional or global significance in terms of losses;
2. tendency to focus on large-scale loss events ("disasters"), denying attention to smaller, cumulative events;
3. tendency to concentrate on death toll as the easiest obtainable, but maybe least telling impact statistic;
4. tendency to emphasize the powerlessness of humans vis à vis "natural" forces;
5. tendency to highlight the value of techno-centric solutions to hazard problems.

Students should present a clear analysis of the extent to which the news articles that they have chosen reflect the myths that Jones describes; they may or may not find all five represented in the paper. For those myths they can identify, students should provide examples. This will give you an opportunity to see whether they adequately prepared for class, understood the readings, and
can apply the knowledge of these myths to a text on hazards.

## Activity 1.4 Differences in Hazard Perception

The results of students' surveys cannot be predicted, as they will depend on the types of environmental risks present, the kinds of neighborhoods surveyed, the gender and ethnic mix, and the survey questions and hypotheses students investigated. Use the list below as a guide for assessing students' work:

- Did students prepare a set of survey questions and research hypotheses, hand them in on time, and make changes to them as suggested before conducting the survey?
- How many people did the students survey? Was there a good mix of people?
- Did students write a clear, concise, and reasonably well explained report?
- Did students make an effort to incorporate background information about the surveyed neighborhoods in trying to explain their findings?
- Did students make use of the readings suggested for this activity, e.g., by referring to claims, research findings, hypotheses, etc. in those studies?
- Did students show a critical awareness of the potential and limits of the survey?
- Did students include graphics, tables, and maps in their report?

# 2 Are Things Getting Better Or Worse?

## Background Information

### Introduction

In this unit we look at trends in hazard occurrences and human vulnerability to the impacts of such events. In the last unit you learned that it is the *interplay* among trends in geophysical events, our technological stage of development, and the proneness to suffer impacts from such events that determines whether people are actually better or worse off now as compared to the past. It is possible, for example, that more hazards are occurring, while we have improved our ability to detect and protect ourselves from them, so that things overall wouldn't necessarily seem to be worse. It is also possible that there are just as many hazards, but they are bigger events and our vulnerability to them has stayed the same. Lastly, it's possible that there have been no changes in the quality or quantity of natural or technological hazards at all, but there are simply more people at risk, and their ability to protect themselves against, and recover from, hazards may have changed over time. Obviously, there are many ways in which nature, society, and technology interact, and consequently as many ways in which any one of them could change over time. The complexity of these interacting factors makes it impossible to answer the question of whether things are getting better or worse.

In this unit, we look at trends in hazards in the context of other global changes, both environmental and societal. Our discussion is divided into three sections. In the first section, we look at the trends in the number of natural and technological disasters; in the second, we discuss problems with the data that underlie these trends; and in the third section, we look at human disaster proneness. Together these sections provide a complex picture of the changes in hazards and their impacts, and they prepare us for the third unit that focuses on responses to disasters and hazards.

### Trends

Are things getting better or worse? Is the world becoming more disastrous? Let's begin by looking at the number of disasters. Disasters, of course, are not the only indicators of hazard trends, but they are more easily measured than others. We need to remember that what is considered a "disaster" is defined by humans. In addition, disaster definitions change frequently and are not consistent from nation to nation, or from one government agency or insurance company to another. We will discuss these data issues further below.

Using United Nations data, we find that the frequency and magnitude of natural disasters steadily increased during the last 30 years with a noticeable peak in 1991, the worst year worldwide for disasters in decades. The less-developed countries suffered about 97% of these disasters and account for about 99% of the deaths attributed to natural disasters (UNEP 1993). While numeric estimates of mortality and injury are often questionable, the loss of life from natural disasters is enormous (Table 5). Tropical **cyclones** and earthquakes are natural hazard events with the most fatalities (see *Focus Issue 2*).

**Table 5: Top Natural Disasters by Lives Lost, 1945-1990**

| *Year* | *Location* | *Type* | *# Deaths* |
|---|---|---|---|
| 1970 | Bangladesh | Tropical cyclone | 300,000 |
| 1976 | China | Earthquake | 242,000 |
| 1991 | Bangladesh | Tropical cyclone | 132,000 |
| 1948 | Soviet Union | Earthquake | 110,000 |
| 1970 | Peru | Earthquake | 67,000 |
| 1949 | China | Flood | 57,000 |
| 1990 | Iran | Earthquake | 40,000 |
| 1965 | Bangladesh | Tropical cyclone | 36,000 |
| 1954 | China | Flood | 30,000 |
| 1965 | Bangladesh | Tropical cyclone | 30,000 |
| 1968 | Iran | Earthquake | 30,000 |
| 1971 | India | Tropical cyclone | 30,000 |

* Based on estimated number of fatalities.

Source: Cutter, Susan. "Societal vulnerability to environmental hazards." *International Social Science Journal* 48, 4 (1996). Oxford, UK: Blackwell Publishers. 525.

## Focus Issue 2: More than Being in the Wrong Place at the Wrong Time

A quick glance at the top natural disasters from 1945 to 1990 (Table 5) reveals that earthquakes and tropical cyclones are the two hazards that contribute most to loss of life worldwide. Major earthquakes are typically of short duration, infrequent, and relatively concentrated in areal extent. Tropical cyclones may have high intensity levels and be spread over large areas, but their impacts are often reduced because of the slower onset, existing warning systems, and ability to forecast where they might hit hardest. But why, if the frequency and magnitude of these events have not increased over the last few decades, is there still such extensive loss of life and increasing losses of property?

Most fatalities from seismic events result from structural failure (Smith 1992). Even the most prepared and developed societies are still subject to heavy loss, as witnessed by the Great Hanshin earthquake in Kobe, Japan in 1995. Still, most events reported in Table 5 occurred within the developing world where adobe clay brick construction is common because it is inexpensive and a good insulator. It does not resist earthquake shaking well, however, as disastrous results in Latin America and the Middle East demonstrate. In developed countries, earthquake damage can also be quite extensive, but would be much greater without seismic-resistant engineering. While loss of life has been reduced, monetary consequences continue to escalate (Table 6), especially in developed countries where infrastructure is more complex and expensive . "Losses" are not simply what gets destroyed, but also include costly replacements. Simple, inexpensive bracing techniques within adobe construction may be a better solution in developing countries where expensive mitigation measures may be difficult to justify, especially when the full costs of construction are not shared equally by those who benefit. This demonstrates the complex interaction of nature and society: the earthquake hazard is not solely a function of the event itself, but also of the social and technological systems that result in a certain architecture, building material, and way of living.

Similarly, tropical cyclones do not occur in a social vacuum. Losses in terms of dollars are worst in developed countries, whereas the death toll is heaviest in developing countries. The latter reflects the common lack of effective warnings and reliable evacuation plans in such areas (Burton, Kates, and White 1993). Political-economic and institutional circumstances seem to maintain or even increase vulnerability for the already worst-off segments of the population (Blaikie et al. 1994). Secondary hazards such as landslides and storm surges affect those people who are already vulnerable because of economic and population pressures that force them to live in exposed places. In the context of global change, both pressures are likely to worsen; changes in resource access and political systems to reverse this trend will not be rapid if they happen at all.

In light of these facts, better warning systems, effective land use, and other strategies for minimizing economic impacts and loss of life will become the necessary engines of change in developed and developing countries. A geographic perspective that integrates the social, politico-economic, technological, and natural environments can provide the necessary understanding to reduce vulnerability from all hazards, including the top killers -- cyclones and earthquakes.

*QUESTIONS:*

- How many catastrophes does it take to change the world? Will it take billion-dollar losses and hundreds of thousands of lost lives to get us to deal with global societal and environmental changes (e.g., population growth, poverty, climate change)?
- Global climate change is thought to alter the frequency of storm hazards; how could a hazard affect global change (pick any hazard or type of global change you want)?
- Despite warnings and hazard experiences, why do people continue to live in dangerous areas?

Economic losses from natural disasters have tripled over the last 30 years and are greatest in the developed world. During the 1960s, for example, disaster losses were estimated at $40 billion; by the 1980s these losses had risen to $120 billion. In the first half of the 1990s, cumulative losses were already beyond $160 billion. Losses from Hurricane Andrew ($30 billion and still rising) and the Northridge earthquake ($30 billion) make these the most disastrous events to affect the United States. In Japan, losses from the Great Hanshin-Awaji (Kobe) earthquake are running at $50 billion (Domeisen 1995). It is paradoxical to note that economic losses from two of the top ten natural disasters since 1945 occurred in the beginning of the 1990s (Table 6), the start of the International Decade for Natural Disaster Reduction (**IDNDR**, see *Focus Issue 3*).

**Table 6: Top Natural Disasters by Economic Losses, 1985-1995**

| *Year* | *Location* | *Event* | *Losses (US$bn)* |
|---|---|---|---|
| 1995 | Kobe, Japan | Great Hanshin Earthquake | 50.00 |
| 1992 | Florida, USA | Hurricane Andrew | 30.00 |
| 1994 | California, USA | Northridge Earthquake | 30.00 |
| 1993 | Midwest, USA | Mississippi Floods | 12.00 |
| 1989 | Caribbean, USA | Hurricane Hugo | 9.00 |
| 1990 | Europe | Winter storm, Daria | 6.80 |
| 1989 | California, USA | Loma Prieta Earthquake | 6.00 |
| 1991 | Japan | Typhoon Mireille | 6.00 |
| 1993 | Northeast, USA | Blizzard | 5.00 |
| 1987 | Western Europe | Winter gale | 3.70 |
| 1990 | Europe | Winter storm, Vivian | 3.25 |
| 1992 | Hawaii | Hurricane Iniki | 3.00 |
| 1995 | Florida, USA | Hurricane Opal | 2.80 |
| 1990 | Europe | Winter storm, Wiebke | 2.25 |
| 1991 | USA | Forest Fire | 2.00 |
| 1990 | Europe | Winter storm, Herta | 1.90 |
| 1991 | California, USA | Berkeley-Oakland Hills fire | 1.60 |

Source: Cutter, Susan. "Societal vulnerability to environmental hazards." *International Social Science Journal* 48, 4 (1996). Oxford, UK: Blackwell Publishers. 525.

## Focus Issue 3: The International Decade for Natural Disaster Reduction (IDNDR)

Organized for the 1990's as a coordinated international program for the reduction of human fatalities, property damage, and social and economic disruption from natural hazards, the IDNDR addresses a number of natural hazards and aims to bring together practitioners and scientists from a number of disciplines and countries. Individual nations are encouraged to form their own Decades for Natural Disaster Reduction, such as the **USDNDR**, to assist with international cooperative projects. These projects generally fall into three categories (NRC 1987):

- the collection, dissemination, or application of existing knowledge and identification of gaps in knowledge;
- applied research that is problem-focused and aimed at filling gaps that have been identified;
- new research that can yield additional knowledge for general application.

Existing *knowledge must be translated into specific plans and actions* that will improve people's chances for survival in a disaster. Most natural disaster fatalities occur in the developing world often resulting from structural failures. Existing information can be applied to improve even the most basic buildings rather than focusing exclusively on the structurally complex. Disseminating information and procedures for hazard mitigation can benefit all societies whose safety is at risk from the failure of facilities, such as dams, chemical production plants, and nuclear power plants.

*Problem-focused research* is meant to unite scientists and practitioners to work on specific hazard situations. Scientists will provide the most up-to-date research results to assist in appropriate mitigation efforts implemented by planning officials. Practitioners will articulate their information needs to researchers. Attention on hazards through the Decade has generated new research as well. New topics will continue to emerge and many require fresh approaches to solve the problems.

Another major goal of the IDNDR is to *facilitate the communication of risk* by improving *warning systems*, educational programs, and information exchange. Warning systems will vary with each hazard, including the time necessary for each to be effective. Modern technologies exist to give earlier warnings for hurricanes and tornadoes, for example, but this ability is not available for all areas of the world. Even if the technology were readily available for all, we have yet to perfect techniques for spreading the warning effectively to all potential victims. Improved accuracy will also reduce the number of false alarms that give rise to community distrust and dismissal of future warnings.

*Educational programs* and the *exchange of information* are key to the disaster mitigation process. Many people need to be made aware of the hazards they're exposed to and how to respond when they occur; and those responsible for disaster response need (additional) training to understand why people react to hazards the way they do. Linking what is learned about how different cultures respond, the experience of those working in the field, and the information gathered on the hazard event by scientists is crucial for the formulation of acceptable and effective mitigation strategies.

Many scientists expect an increase in disasters from global change processes that will place more people at risk unless existing knowledge is shared and used more effectively. While it is not possible to prevent all hazards, especially those events originating in the natural environment, we can avoid or mitigate some of their impacts. The IDNDR provides the impetus for research, risk communication, and practical implementation projects to come together internationally, and it allows individual nations working together with others to provide hazard information and mitigation strategies sooner than if they attempted to do so alone.

Some people view industrial accidents rather fatalistically as unavoidable by-products of economic development. Others simply dismiss them as unintended "side effects" of technical processes that will be avoided in the future thanks to technological progress. Edward Tenner goes a bit further and calls them "revenge effects" -- results of technology interacting with real people and real environments (Tenner 1996; see also the classic work by Charles Perrow 1984). And yet others, like the quite radical German sociologist Ulrich Beck, think of industrial disasters as the failures of an industrial-capitalistic complex, as the results of "institutionalized neglect" (Beck 1995, 86), that undermine the vitality of industrial society.

Whatever outlook one takes on technological hazards (which eventually become industrial, health, or consumption hazards), they seem to be less catastrophic than natural hazards in terms of lives lost from single events (Table 7). This claim can probably not be upheld for chronic technological hazards that hurt or kill thousands of people every year but which are much more difficult to show statistically and demonstrate causally (car driving, smoking, and air pollution are excellent examples). Even single events often do not result in immediate fatalities, but pose long-term threats to human health and ecosystem stability. Of course, to relate any of these long-term effects back to a single cause like a toxic materials spill, a nuclear accident, or water pollution is very difficult. Most human and ecosystem health problems have multiple causes, depend on susceptibility and resistance, and have great geographic, ecological, and individual variation in whether, how, and when such problems arise. Our limited understanding of nature-society interactions and our methodological and technical inability to detect cause-and-effect connections prevent us from completely documenting the entire range of technological hazards to people and the environment.

## Table 7: Top Industrial Disasters by Lives Lost, 1945-1990[a]

| *Year* | *Location* | *Type* | *# Deaths*[b] |
|---|---|---|---|
| 1984 | Bhopal, India | Toxic vapor/methyl isocyanide | 2,750-3,849 |
| 1982 | Salang Pass, Afghanistan | Toxic vapor/carbon monoxide | 1,500-2,700 |
| 1956 | Cali, Colombia | Explosion/ammunition | 1,200 |
| 1958 | Kyshtym, Russia | Radioactive leak | 1,118[c] |
| 1947 | Texas City, TX | Explosion/ammonium nitrate | 576 |
| 1989 | Acha Ufa, Russia | Explosion/natural gas | 500-575 |
| 1984 | Cubatao, Brazil | Explosion/gasoline | 508 |
| 1984 | St. J. Ixhautepec, Mex. | Explosion/natural gas | 478-503 |
| 1992 | Zonguldak, Turkey | Mine explosion/gas | 388 |
| 1983 | Nile River, Egypt | Explosion/natural gas | 317 |
| 1992 | Guadalajara, Mexico | Sewer explosion/gas | 210 |
| 1986 | Chernobyl, Ukraine | Explosion/radioactivity | 31-300[c] |

[a] Based on estimated fatalities
[b] Estimates vary widely depending on the source(s) used; therefore ranges are provided where discrepancies exist.
[c] Reported fatality figures reflect immediate deaths only, not longer-term fatalities associated with the exposures.

Sources: Data extracted from Cutter 1994; UNEP 1993; Tolba et al. 1992.

Many industrial accidents are associated with energy production and distribution such as oil tanker accidents (Exxon Valdez or Aegean Sea) and intentional spills (Persian Gulf conflict in 1991), an observation that links hazards again with global economic and climatic changes. Chemical disasters have steadily increased since the 1960s with a decline in industrial accidents during the 1990s. As was the case with natural disasters, two of the top industrial disasters occurred in 1992 -- the mine explosion and gas leak in Zonguldak, Turkey, and the sewer gas explosion in Guadalajara, Mexico, which killed 210 people.

To summarize, natural disasters are more prevalent in the less-developed countries where increasing urbanization and environmental degradation cause people to be more vulnerable to the impacts of natural events. In addition, developing countries often lack the technological know-how or facilities to warn and rescue populations at risk before disaster occurrence. Southern and eastern Asia have the greatest fatality rate from natural disasters, with Bangladesh topping the list of individual countries.

The risk of industrial hazards, on the other hand, is greater in developed nations because they simply have more industrial facilities. On the other hand, as Table 7 indicates, more industrial disasters have occurred in the developing countries. This again points to a complex set of interacting factors like populations at risk, safety standards, warning systems, functional precautionary measures, and effective emergency response strategies.

Independent of region or type of hazard, disasters seem to be increasing over time, especially during the past decade. While global environmental changes may or may not play a role in these trends, it is possible to conclude that the major cause for this increase is that greater numbers of people and more valuable property are at risk and are affected by hazard events. Having arrived at these preliminary conclusions about disaster trends, we will now look at the availability and quality of data about hazards and disaster events and how this requires us to be cautious in making bold statements about global disaster trends.

## Data Constraints

A number of problems with data restrict our understanding of the broad patterns of hazards distribution and society's responses to them. While some international comparative statistics exist, we must question their completeness and reliability. Inaccuracies, inconsistencies, and omissions in reporting and record keeping are among the most common problems that affect the value of information (see *Focus Issue 4*). Often the most basic data on disaster events such as location, magnitude, and duration are missing, incomplete, or withheld for national security purposes. Measuring the impacts of disasters poses even greater problems. Most data bases concentrate on three main criteria: mortality, number of people affected, and damage estimates (usually in US$). Each of these indicators has a bias in data collection. For example, most of the damage estimates are made in local currency and then adjusted to the US dollar standard. Fluctuations in exchange rates and inflation from year to year often render these estimates meaningless, especially in determining long-term trends. None of the national or international statistics take human perceptions of hazards into account, thus giving only a very rudimentary picture of the events. If we were to use other than official data sources to make up for this absence (i.e., reports in the news media), we would most likely obtain a colorful but also biased insight into the world of hazards. Media tend to focus on the high-mortality, high-loss events in developed or at least physically accessible countries. Finally, for any trend analysis we encounter the additional problem that records have not been kept consistently and often exist for only the most recent years in many countries.

The United Nations Environment Programme (UNEP) maintains a disaster data base but reports only those disasters with at least 30 immediate fatalities. In addition to the UN, the Center for Research on the Epidemiology of Disasters (CRED) in Brussels, Belgium and the U.S. Office of Foreign Disaster Assistance also maintain global data bases on natural disasters (International Federation of Red Cross and Red Crescent Societies 1995). Clearly, all of these efforts focus on disasters arising from single extreme natural events. Rarely are multiple origins considered (e.g., a severe winter storm with high winds, snowfall, ice, and coastal flooding) or hazards arising from more chronic conditions such as drought (which could facilitate a famine disaster or forest fires).

Human-induced hazards are increasing in importance, yet relevant global data are hard to find. Oil spills, chronic toxic contamination, and pollution are good examples. Industrial accident data are collected (the OECD data bases are among the best), as are statistics on oil spills

(International Tanker Owners Pollution Federation Limited, Oil Spills Intelligence Report), and nuclear accidents (International Atomic Energy Agency or IAEA). Data on the transboundary movement of hazardous waste is difficult to acquire because of the lack of international agreement on what constitutes hazardous waste. One attempt to remedy this situation is the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Disposal (1989) which sets up obligations to minimize waste amounts, toxicity, and transboundary movement (WRI 1992). This agreement comes closest to a universal definition by providing a list of regulated categories of hazardous waste. Let's not forget, however, that in a number of cases the nature of a shipload of waste is quite clear but issues of secrecy overshadow its proper declaration and safe handling. Other sources of data on toxic materials include UNEP's International Register of Potentially Toxic Chemicals (IRPTC) and the APELL (Awareness and Preparedness for Emergencies at Local Level) Programme (Tolba et al. 1992).

Unfortunately, basic data on the range and extent of hazards has not kept pace with the needs. Detailed information on the human occupance of hazard zones and on human adjustments to hazards is generally available only at a local level. We can monitor and even model the physical systems response to hazards and ultimately assess the biophysical impacts at both the global and local levels. There are, however, few global data bases on human occupance and societal adjustments to environmental hazards which would allow us a better understanding of why and how people live where they live, and which -- ultimately -- could be combined with the biophysical impact models to gain a more complete understanding of nature-society-technology interactions. Moreover, the problems that affect the reporting of disaster and hazard data also affect the capturing and reporting of other social data, thus leaving us with unreliable information about many world regions and further hampering our efforts to assess the social consequences of environmental hazards.

**Focus Issue 4: Getting the Numbers Right: The Case of the Center for Research on the Epidemiology of Disasters** (adapted from *World Disaster Report*, 1994)

A major problem facing hazards researchers is data. Plagued by little data or data of questionable reliability, researchers often find they have to make a leap of faith. In an effort to bridge the gap from what is observed in the field to what is reported in the literature, the Center for Research on the Epidemiology of Disasters (CRED) created a database (*World Disaster Report*) that relies heavily on the maintenance of convention in the reporting of disaster statistics.

In 1994, the database was fully operational with more than 9,000 records of disaster events, and its own menu for updates, modification, and retrieval. It includes figures on people killed, injured, affected, and made homeless by individual disasters or averaged over regions and periods of time. Such listings raise difficult questions which CRED had to grapple with extensively -- What is a "disaster?" How is "injured" different from "affected?" or Is "homeless" also considered part of "affected?"

CRED's strict criteria for a disaster event to enter their database are: 10 deaths, and/or 100 affected, and/or an appeal for assistance. In cases of conflicting information, priority is given to data from governments of affected countries, followed by those from UNDRO, and then the US Office for Foreign Disaster Assistance (OFDA). Agreement between any two of these sources takes precedence over the third. This does not reflect the value placed on the quality of data; most reported sources have vested interests, and figures may be affected by socio-political considerations. The OFDA, for instance, reports only those disasters to which it had to respond with assistance.

Figures for those killed in disasters include all confirmed dead and all missing and presumed dead. Frequently, in the immediate aftermath of a disaster, the number of missing is not included, but may be added later. Because there are no international standards, definitions vary from source to source so that CRED must check each entry for classification. Included in the injured category are those with physical injury, trauma, or illness requiring medical treatment as a direct result of a disaster. First aid and other care provided by volunteers or medical personnel is often the main form of treatment provided at the site of the disaster, but it has not been decided whether people receiving these services should be included as injured. Homeless is defined as the number of people needing immediate assistance with shelter. Discrepancies may arise when source figures refer to either families or individuals. Average family sizes for the disaster region are used to reach consistent figures referring to individuals. Defining "persons affected" is extremely difficult, and figures will always rely on estimates, as there are many difficult standards, especially in major famines, conflicts, and the complex disasters of the former Soviet Union and Eastern Europe.

Disparities in reporting units can be a problem, such as monetary value of damages expressed in either US dollars or local currencies. While it is simpler to leave currencies as they are reported and to correct them only when the event is of interest, it can slow the comparisons and computations required by data users. Dates are also a source of ambiguity; the declared date for an event such as famine is both necessary and meaningless, since famines, population movements, conflict, and epidemics can rarely be pinpointed to occur on a single day. In such cases, the date of declaration of an emergency by the appropriate body is used. Further ambiguities exist because of changes in national boundaries over time (e.g., the break-up of the Soviet Union or Yugoslavia or the unification of Germany). In such cases, no attempt has been made to disaggregate or combine data retrospectively. Data are presented for the country as it existed at the time the data were recorded.

Despite efforts to unify, cross-check, and review data, CRED takes no responsibility for a figure but can always provide the data user with source information. It is hoped that the complexity and cost of compiling comparable data will decrease in the future. In the end, the higher data quality will have a greater pay-off to hazard managers.

## Disaster Proneness

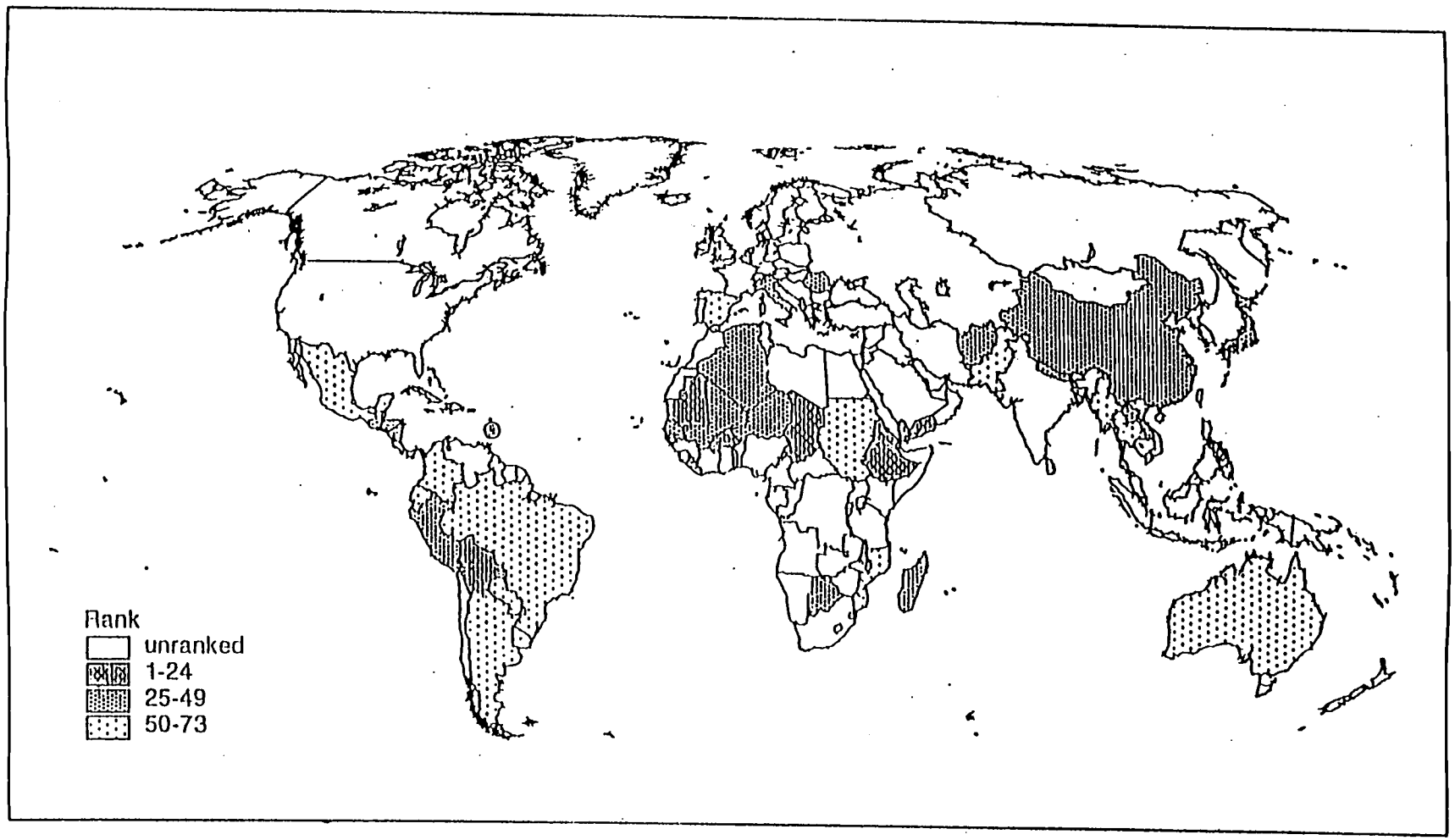
In 1990, United Nations Disaster Relief Office (UNDRO) produced its first assessment of the vulnerability of nations to natural disasters. Working within the framework of economic impacts caused by natural disasters, UNDRO created its **disaster proneness index** for individual countries (see Figure 1). The index provides a measure of the total economic effect of disasters over a 20-year period as a percentage of the total annual GNP. Only significant disasters, defined as those causing financial damages assessed at more than 1% of the country's annual GDP were included (UNEP 1993). While preliminary in nature, fraught with all types of assumptions, and bound by the data constraints mentioned earlier, the disaster proneness index does provide some global comparative statistics on the vulnerability of countries to disasters.

Not surprisingly, some of the most disaster-prone countries are those with hazards with frequent recurrence intervals (such as tropical cyclones) and "hits" during the last 20 years (the period of study). Thus, Caribbean countries such as Montserrat, Dominica, and St. Lucia and the Pacific island nations of Vanuatu and Cook Islands rank among the top ten. Other countries had only one disastrous event during the last 20 years that inflated their ranking on the index. Figure 1 maps the disaster-proneness of countries. In addition to the island nations mentioned above, Central American nations (El Salvador, Honduras, Nicaragua), Sahelian countries (Burkina Faso, Ethiopia, Mauritania), and Asian countries (Bangladesh) are the most disaster-prone. The inverse relationship with national wealth comes as no surprise: not only are these nations the most disaster-prone, they are among the least able to respond in the aftermath of a disaster and to mitigate the impacts of future ones.

While suggestive of some general patterns, the disaster-proneness index does not measure those factors that cause the increasing vulnerability of countries to hazards. We know that urbanization, industrialization, and technology all influence the types and level of impact of hazards on places, often making local residents more vulnerable to hazards. Rapid urbanization, especially of **megacities** in geophysically dangerous regions (like Miami, Tokyo, Sao Paulo, Cairo, Lima, or Shanghai), leads to a concentration of people in ever more marginal areas such as hillslopes or in coastal floodplains. Coincidentally (but not accidentally), these areas are often less developed, without proper infrastructure, far removed from emergency response institutions, and occupied by the poorest members of the population (Blaikie et al. 1994).

This kind of pattern is not replicated equally worldwide. In some older North American cities, for example, as the city center is abandoned by residents for the greener, less crowded outskirts of town, new hazard mitigation techniques are implemented in the expanding suburbs only. Conversely, other cities respond to threats with hazard-sensitive designs within their centers but lack the same attention to their periphery, such as in Mexico City with its ever expanding squatter settlements. Often, hazard mitigation and disaster reduction strategies simply don't keep pace with the sheer volume of new arrivals of people in the megacities (Mitchell 1995). The Kobe earthquake seems to indicate a similar center-periphery pattern. Tokyo, the capital of Japan and one of the world's most important financial centers, has been the focus of extensive earthquake

## Figure 1: UNDRO's Disaster-proneness Index




Source: Cutter, Susan. "Societal vulnerability to environmental hazards." *International Social Science Journal* 48, 4 (1996). Oxford, UK: Blackwell Publishers. 525.

mitigation activities while large cities nearby that are equally at risk from seismic hazards have received fewer resources to implement the necessary construction and engineering changes to protect themselves from structural collapse.

Clearly, the spread and growth of industrialization not only creates goods for the marketplace and lures people into urban centers, but also generates unwanted waste byproducts, such as air pollution and contaminated water. These more chronic and less visible hazards are nonetheless parts of the hazardscape of people living in places at risk from more dramatic hazards. Moreover, industrial wastes are being shipped across the globe, mostly from developed countries to developing nations. The import of hazards from elsewhere results in recipient populations being placed at even greater risk, while also endangering those along the travel path of waste (Puckett 1994).

What this amounts to is that population pressures, poverty, political-economic relations between and within nations, as well as ethnic and gender relations (see *Focus Issue 5*) influence the degree of vulnerability of certain segments of the population. Generally speaking, the poorest populations of developing countries are most susceptible to the impacts of disasters once they occur. Bangladesh, with the crowding of its landless poor onto small offshore islands for farming, is a case in point. These people are more vulnerable to storm surge from cyclones, less able to make adjustments because of their poverty, and least likely to receive adequate early warnings since warning systems and communication infrastructure aren't present. These spatial and temporal dimensions to biophysical and social vulnerability are not fully understood and have not been incorporated into the U.N.'s disaster-prone index although they are critical to understanding why some countries and certain populations within them are disproportionately affected by hazards.

And yet, even without a good understanding of the interplay of biophysical and societal vulnerability, it seems clear that societal trends are important in determining the outcomes of hazards. Hazards and global change experts thus now maintain that even if global environmental changes did not materialize, e.g., if storms did not happen more frequently or hurricanes did not intensify, we could still see worsening disaster trends in terms of losses of lives and property. Those already disadvantaged in society would likely be the people hit hardest and at the same time least able to recover from disastrous events.

## Focus Issue 5: Disasters Make Us All Equal -- Or Do They Really?

When you think of hazards like the nuclear power plant explosion in Chernobyl (1986), the release of deadly gases from the Union Carbide plant in Bhopal (1984), one of the most dreaded summer hazards of the U.S. -- a tornado -- cutting a deadly path right through the center of Worcester, Massachusetts (1953), or the life-threatening depletion of stratospheric ozone, it doesn't seem to make much difference whether you are male or female, young or old, of this or that ethnic origin, rich or poor, or for that matter, whether you are a human being, a cow, or a tree. Everything and everyone is affected by nuclear radiation, toxic gases, the unimaginable force of tornadoes, or the ozone hole. In that sense one could argue that disasters make us all equal. But is that really so? And even if it held true for such violent forces like a tornado, would it hold true for all types of disasters?

For some time in hazards research, no distinctions were made among victims. Even today it is still common for epidemiologists and toxicologists to extrapolate risk estimates for a specific group of people (e.g., the average male, white, middle-aged American) on to larger heterogenous populations. Some controversial recent work in technological and global environmental hazards by Ulrich Beck (e.g., 1995) also maintains that we all live in a risk society and are -- as a whole -- equally vulnerable to be wiped out by "mega-risks."

On the other side, an increasing number of studies highlight how different people suffer varying degrees and types of losses from one and the same hazard (hence, the branch of vulnerability research). There are differences in exposure to hazards, in our ability to protect ourselves from their occurrence, and in our ability to recover from their impacts. One study, for example, showed how women and children have -- against what you would expect physiologically -- a higher mortality rate than men in situations of hunger and famine, the reason being the sex discrimination inherent in most sociocultural systems (Rivers 1982). Elderly populations in coastal, hurricane-prone areas are more vulnerable than young people to the effects of severe storms because of their reduced mobility, lack of or fewer linkages with community networks, and lack of communication with emergency personnel. Cutter (1995) pointed out that because of children's body weight, relative food intake, behavior, and stage of physiological development, they are disproportionately more exposed to environmental toxins than adults. Over the past decade or so, a strong grassroots movement emerged, focused entirely on inequities between ethnic minorities and the white majority of the U.S. population experiencing different degrees of environmental risk (see, e.g., Bullard 1990; Baugh 1991; Graham and Richardson 1995). Much of this environmental justice movement revolves around toxic waste and pollution originating from noxious facilities, which some studies claim are more likely to be located in poor and minority neighborhoods.

Even if we go back to the examples used in the introduction of this focus issue -- nuclear accidents, releases of toxic gases, tornadoes, and loss of stratospheric ozone -- can we maintain the proposition that those hazards make us victims all the same? We certainly can't in the case of radiation of, say, a fetus versus its mother; or stratospheric ozone depletion affecting the skin of a voluntary sunbather versus that of an outdoor construction worker earning a living; even in the case of a twister, if one such storm rages through a suburb versus downtown at 10 am or at 3 am different types of people will be affected..

*QUESTIONS:*

- Are hazard exposure and experience simply random or are there *demonstrable* systematic biases in who is exposed to and who experiences hazards?
- How could you as a hazard manager take social differentiation into account in designing mitigation strategies aimed at reducing vulnerability?

# 2 Are Things Getting Better Or Worse?

## Instructor's Guide to Activities

### Goals

Students understand that the answer to whether things are getting better or worse depends on who is affected by hazards and global changes and on one's viewpoint.

### Learning Outcomes

After completing the activities associated with this unit, students should:

- have a critical understanding of current disaster impact trends for various hazards;
- be able to detect geographic and societal variations in hazard trends;
- understand the crucial importance of vulnerability in determining present and future disaster impacts, and be able to identify factors that affect societal vulnerability;
- be able to make a carefully stated connection between hazards and global change;
- be able to assess critically the options the insurance industry has in dealing with climate change;
- be able to search for hazards data using the World Wide Web and using local sources (library, agencies, etc.); and
- be able to plot, map, analyze, and interpret various types of data.

### Choice of Activities

It is neither necessary nor feasible in most cases to complete all activities in each unit. Select those that are most appropriate for your classroom setting and that cover a range of activity types, skills, genres of reading materials, writing assignments, and other activity outcomes. This unit contains the following activities:

| | |
|---|---|
| 2.1 Trends of Individual Hazards | -- Web data search, charting of hazard occurrences and visual time series analysis |
| 2.2 How Vulnerable is Your Community? | -- group- and class-project to assess vulnerability to a local hazard, integrating contributing factors |
| 2.3 The Hazards-Global Change Journal | -- keeping record of hazards reporting in the news media, analysis of hazard-global change linkage |
| 2.4 Insured Until Death Do Us Part... | -- role play and debate on the stance of the insurance industry vis à vis global climate change |

## Suggested Readings

The following readings accompany the activities for this unit. Choose those readings most appropriate for the activities you select and those most adequate for the skill level of your students.

- Unit 2 "*Are Things Getting Better or Worse?*"

  The Background Information of Unit 2 that all students should read.

- Cutter, Susan L. 1995. The forgotten casualties: Women, children, and environmental change. *Global Environmental Change* 5, 3: 181-194.

  A readable scientific article that highlights issues of social, inter-generational, procedural, and geographic inequity in the impacts of hazards and global changes. Cutter shows how women and children are caught in a poverty-population growth-environmental degradation spiral which puts them at greater risk from hazards and causes relatively greater impacts for them than for more advantaged members of society.

- Burton, Ian, R.W. Kates, and G.F. White. 1993. Emerging synthesis. In: *The environment as hazard*, 241-263. Second edition. New York, NY: Guilford Press.

  This last (and newly added) chapter to the second edition of the classic text on hazards summarizes some of the recent developments in hazards research and relates it to the emerging global change and sustainability research agendas. It also highlights vulnerability studies and the International Decade for Natural Disaster Reduction, and thus serves well as a follow-up to the Background Information provided in this module.

- Showalter, P.S., W.E. Riebsame, and M.F. Myers. 1993. *Natural hazard trends in the United States: A preliminary review for the 1990s.* Working Paper # 83, Natural Hazards Research and Application Information Center, University of Colorado, Boulder.

  The authors summarize US natural hazard trends since the mid-1970s, including an assessment of the difficulty of doing such trend analyses. Their aim is to provide baseline data against which progress in hazards mitigation can be measured. The paper is available from the NHRAIC, Institute of Behavioral Science # 6, Campus Box 482, University of Colorado, Boulder, CO 80309-0482; also through the Center's Web site at http://adder.colorado.edu/~hazctr/Home.html. ***Allow sufficient time to acquire the paper!***

- Flavin, Christopher. 1994. Storm warnings: Climate change hits the insurance industry. *World Watch* 7,6: 10-20. (provided)

  Of the many articles of recent years on insurances and the prospects of global change, this may be the best summary to date of the issues at stake for both the industry and those affected directly by hazards. For the insurance industry -- whether or not climate change is the causal factor behind its staggering and increasing losses -- the answer to the question of whether things are getting better or worse is clearly "worse!"

- Cutter, Susan L. 1996. Societal responses to environmental hazards. *International Social Science Journal* 48,4 (1 December).
  Reflects on the various definitions of vulnerability, draws out commonalities, and then applies specific aspects of vulnerability to global change and hazards.

## Activity 2.1 Trends of Individual Hazards

### Goals

Students learn that hazard trends are influenced by processes and causes of global change. Students use what they learned in Activity 1.2 about the spatial variation of hazards to examine regional variations of a particular hazard to see if changes are consistent in all areas. Students also understand the parameters useful in describing global environmental change in order to speculate on the processes and causes of global change influencing the trend in their hazard.

### Skills

- ✔ using the Internet/WWW as a research tool
- ✔ plotting data along a time line
- ✔ visual time series analysis

### Material Requirements

- *Student Worksheet 2.1* (provided)
- *Appendix A: Selected Internet/WWW Hazards Sites* (provided)
- Individual world maps (approx. 8.5"x 11")
- Computer terminals with access to Internet/WWW (assigning students to small groups will reduce the necessity for many computers)

### Time Requirements

1 week of out-of-class preparation of the time line, maps, and reports
approximately 15 minutes in-class discussion of findings

### Tasks

This is a computer-based activity involving the Internet and the World Wide Web. Students gain insight into the global and regional trends of hazards occurrence and make links to global change. In studying the transformation of the earth, five specific dimensions are useful in describing global environmental change including:

- the seriousness of the changes (magnitude),
- the speed of changes occurring (rate),
- the location and spread of occurrence (patterns),

- the way they come about (processes), and
- the reasons they happen (causes).

In this assignment, students examine the first three dimensions -- magnitude, rate, and pattern. Students conduct a visual time-series analysis for a particular hazard. The choice of hazard type (e.g., flooding, chemical spills, drought) can be left to the individual or group of students. Students' final reports should include speculation on the processes and causes of global change that may be influencing the trend in their hazard. They should produce a chart (or time line) illustrating the trend in the hazard they've selected. At first, they should examine the rate and magnitude of change at the global level over a selected period.

**Magnitude** could be indicated by calculating an overall percentage change over the study period, and the **rate** of change could be calculated by dividing the overall change figure (magnitude) into 3-, 5- or 10-year intervals and calculating changes for each. From this, students can assess whether the overall change occurred in one "spurt" or whether the rate of change is periodic, or steadily increasing or decreasing.

Students then examine **regional variations** in the hazard to determine whether some regions are experiencing greater or lesser degrees of change. For this purpose, students will need data at various scales (global and regional) to calculate the magnitude and rate of change overall and for each region. If this activity is adapted to focus on just one country, then students will need data at national and subnational scales. This latter option must account for the fact that different regions of a country may be characterized by different hazard occurrences. For example, a comparison of the storm frequencies in the US Northwest versus the US Northeast must consider that frequencies are at different levels to begin with.

Regional variations could be nicely mapped, for example, by superimposing size-reduced time lines on a world (or national) **map**. For example, you may find numbers of severe storms for different world regions over time, make time lines for each region, and then place these charts over each region respectively. Percentage changes can be calculated separately. You may want to show students an example of this rather common way of mapping from any research article of which you are aware. The mapping of the charts will give students some basic experience with thematic mapping and help them get an overview of the regional differences in hazard changes.

Finally, students write up the results of their investigation. Their narrative should include the following items:

- charts of a chosen hazard(hazard frequency or losses over time) at a larger and a smaller scale
- indications (calculated and descriptive) of magnitude, rate, and regional variation of change
- map of regional frequency changes (optional, but recommended)
- speculation on reasons for frequency changes

You may choose to assign this activity individually or to small groups. If the activity is done in groups of 3-4 students, one report per group should be handed in. Remind students, however, to share the responsibilities of gathering information, data analysis, and writing the final report, even if they decide to split up some of the tasks. Tell them that each student should be able to do each step of the activity. Groups can focus on a particular region or on different hazards. Feel free to let students choose their hazard and region. Alternatively, you can select five to ten hazards that you feel are well documented by accessible data or that better illustrate different hazard profiles over time.

Be sure to verify the Internet and Web sites prior to assigning the activity because the links and addresses in *Appendix A: Selected Internet/WWW Hazards Sites* are subject to change. If you have not completed Activity 1.2, check there for suggestions of good entry points to Web sources on hazards. (Note that the *Virtual Library* lists hazards *by type* and *by country*, but only about 10 countries are offered at the time of writing.)

If you have the time, ask students to summarize briefly their research difficulties and findings in class the day they hand in their reports. This may take about 15 minutes and could be used as a lead-in to a class session on societal vulnerability to hazards.

If you do not have Internet access, you can adapt this activity by using the publications and data sources listed below:

- Office of US Foreign Disaster Assistance/US Agency for International Development. 1996. *Disaster history: Significant data on major disasters worldwide, 1900-1995.* Washington, DC: OUSFDA. (This publication (of which earlier versions exist) lists disaster with date of start, date of disaster declaration, region, country, type of hazard, numbers of people killed, affected, made homeless, an estimate of losses in US dollars, and additional comments.)
- International Federation of Red Cross and Red Crescent Societies. 1995. *World disasters report.* Geneva.
- National Safety Council. 1995. *Accident facts.*
- National Research Council. 1989. *Reducing disasters' toll: The US Decade for National Disaster Reduction.* National Academy Press, Washington, DC.

## Activity 2.2 How Vulnerable is Your Community?

### Goals

Students bring the concept of vulnerability closer to home by creating a qualitatively integrated assessment of their community's vulnerability.

### Skills

✔ group discussion

- ✔ team work (negotiating tasks, responsible task completion, integration of member's parts)
- ✔ analytical and integrative (systems) thinking
- ✔ application of abstract concept and conceptual understanding to an actual situation
- ✔ data acquisition

## Material Requirements

- *Student Worksheet 2.2* (provided)
- access to local data sources (libraries, archives, local agencies, Internet)

## Time Requirements

15-20 minutes (first class session), 50-60 minutes (second class session)
1 week of out-of-class preparation for students (data collection and report preparation)

## Tasks

In this activity, students focus on a local hazard and determine what factors contribute to the community's vulnerability to it. If your class is large, you may subdivide the class and have each subdivision focus on a different hazard. Each subdivision should still be large enough to form sub-groups within it to complete separate tasks. The activity is done partially in class and partially outside of it. You may either choose the hazard(s) for the students to investigate or let the students decide for themselves.

Begin this activity by asking all students to take 3 minutes to write down some of the factors they believe contribute to a community's vulnerability to the selected hazard. A "community" could be an entire town or a particular neighborhood in a city. Giving them some time to write down their ideas focuses students and may encourage those who usually do not contribute to speak up or have answers when you call on them.

Collect students' ideas on an overhead and group them into categories, such as **environmental**, **socioeconomic**, **demographic**, **technological/structural**, and/or **institutional/management** factors. Grouping items into these categories may produce some discussion -- a useful way to clarify the conceptual understanding of vulnerability.

Next, use your classified list of factors that influence the degree of vulnerability to assign various tasks to students. Divide the class (or class subdivision) into groups of several students each. Each group will focus on one category of factors and investigate the **actual situation** of these factors in their community (described in more detail below). Also decide on a sequence in which groups report back to the class (could be done through a lottery), as they need to relate their findings to those of the previous group reporting. Knowing which factor-group goes before them, students can prepare accordingly. Students will not have to know the exact results of the other group to make these connections; rather, they should think logically about how a factor, say from the socioeconomic category, is connected with one in the demographic or institutional category, and so on. Use examples like the following (Table 8 below) to indicate to them what types of connections they should be able to make:

**Table 8: Examples of Connections Between Factors that Affect Vulnerability**

| Factor Group 1 | Factor Group 2 | Examples of a Connection |
|---|---|---|
| SOCIOECONOMIC<br>Low income | INSTITUTIONAL<br>Availability of shelters | Low-income residents may not have easy access to shelters |
| DEMOGRAPHIC<br>Many minorities | INSTITUTIONAL<br>Availability of hazard information | Is hazard information (how to prepare, what to do in case of emergency, etc.) available in all needed languages? |
| TECHNOLOGICAL<br>Building codes | DEMOGRAPHIC<br>Housing stock | What portion of the population lives in homes built according to building codes (compare date of instituting building codes with age of structures)? |
| ENVIRONMENTAL<br>Extent of high-hazard zone | INSTITUTIONAL<br>Preparedness | What precautions have been implemented for the high-hazard zone to prevent or contain an event? Is there an emergency plan for this area? |

Once students come back with their results, the groups will contribute to a composite picture of community vulnerability by reporting their findings (through a spokesperson) to the rest of the class. As they give their report (in no more than 5 minutes each), they should connect their findings to those of the other groups (an additional 2 minutes). The first group states where it sees potential connections to the other groups, every next group needs to connect to the findings of the previous group. This way of reporting group findings has several effects: (1) it reestablishes this activity as a class project; (2) it forces students to think in systems-terms, i.e., to see the connections between factors affecting vulnerability; (3) it forces them to pay attention to each group's report; and (4) it challenges them to integrate newly obtained information into previously existing knowledge.

To find information on each of the factor groups, students will have to consult a variety of sources and each group will not use the same ones. Some of the information will be quantitative, other information will be qualitative. Possible sources include Census data (demographic, socio-economic, housing), maps (geophysical, floodplain, insurance rate, land use, etc.), the Internet (city home pages, state and federal agency home pages), publications from local agencies (state emergency center, department of the environment, Geological Survey, Red Cross, city

government offices, etc.), interviews with agency representatives (by phone or in person) or companies (those that pose risks in particular).

Students will find that some of this information is rather difficult to come by, especially at the community scale, and that the information they bring together is not easily compatible in terms of scale, resolution, age of data, accuracy, etc. It is likely, however, that this activity will produce one of the most thorough assessments of vulnerability for their community. As students report their findings and qualitatively put the mosaic together, these issues will come up or should be pointed out to them. Be careful not to let students get discouraged because of the difficulties with the data. This is not a data and number-crunching activity, but one of applying an abstract concept to a local example and, in the process, demonstrating the usefulness (if not necessity) of the vulnerability concept and some of the difficulties of using it practically in hazard management. The in-class reports and piecing together of vulnerability factors should conclude with an assessment of vulnerability in light of these conceptual and practical realities.

## Activity 2.3 The Hazards-Global Change Journal

### Goals

Students learn how different types of information sources report on hazards and global change issues by assessing the ways that editors, reporters, citizen groups, and individuals gear their writing to different audiences at different geographic scales.

### Skills

- ✔ consistent journal keeping
- ✔ critical thinking
- ✔ news media analysis and synthesis
- ✔ report writing
- ✔ assuming the role and tasks of a consultant

### Material Requirements

- *Student Worksheet 2.3* (provided)
- Access to various types of news media (radio, TV, magazines, local to international newspapers)
- Personal journal

### Time Requirements

2.5 weeks for the journal keeping, analysis, and preparation of a report
25 minutes of in-class discussion

## Tasks

In this activity, students assume the role of consultants to a news media consortium that charges them with the task of assessing the ways in which various media report on hazards and global change issues and recommending specific improvements if necessary.

In a journal, students take notes on how hazards, global change and the links between the two are reported in various news media. Students will look at **different types** of media, at media that report at **different scales** (e.g., comparing a local, national, and international paper), and at the **various means** used to report these issues (words, graphics, maps, live reports, flyers, etc.).

Hardly a week goes by without some hazard becoming public somewhere in the world. Whether one hears about it, how much one hears, and how the events are reported and explained depends on a range of factors. These factors are what students will consider in this activity and include the following:

**What** did you hear about?
**Where** did you hear about it?
**How** was it reported?
**Who** is affected and who is responsible?
**Why** did it happen?

The range of news media is vast and includes local newspapers, US national newspapers (e.g., USA Today, The New York Times), and foreign national newspapers (e.g., Le Monde); any TV station (e.g., CNN, ABC, NBC, the Weather Channel); radio stations (e.g., National Public Radio, Public Radio International, BBC, any local station); information flyers from local citizen groups; weekly news magazines (e.g., Time, The Nation, In These Times); and governmental agencies (departments of environmental protection, state or federal emergency management agencies, Coast Guard, etc.). The coverage of each in terms of form, length, and content will differ depending on audience, scale, mode of communication, political orientation of the editorial board, mission, and so on. Let students choose their preferred type of news media or assign students to ensure that a range of media is covered in class. If the class is large, divide students into small groups for the activity.

Below is a specific list of items students are asked to look for as they follow the news for the next few weeks. Remind them to take notes on the reporting **every day** so they'll recall the details. Suggest that they cut out newspaper articles, make copies, or record or videotape items.

- How many stories related to hazards and global change did I hear today (itemize them)?
- What happened in each event according to the news I focused on (short summary for yourself)? Were initial reports changed significantly later on?
- Where and when did the event occur?
- How much space was allocated to each report (columns/lines or time on the radio/TV)? How did the space allocation change over time?
- Did the report include any maps, graphics, photographs, live reports, interviews with victims or witnesses? What did these items highlight about the events?

- Who reported (author, press source, speakers...)?
- If the hazard was a "natural" hazard, was any connection made to global change? Do you feel it was correct, insufficient, or misleading in any way?
- If the hazard was a "technological" hazard, were there any indications of blame or assigning responsibility?
- What was the explanation for why the hazard occurred or for why the damage was what it was?

In a five-page consulting report, students summarize the information they gathered on each of the above questions. What similarities did they detect in the ways hazards were reported? Were there any significant differences in reporting between types of hazards? Or differences in reporting between hazards that occurred in different locations of the world? Was there any kind of information about the hazards (and/or the linkage to global change) that they felt was missing, wrong (according to what they know about the hazard or location), obviously biased in any way, particularly helpful, or surprising? What made the reporting good or bad, sufficient, not enough, or too much? How did the graphics, maps, photographs influence their understanding and interpretation of the event? And finally, ask them to conclude their reports with recommendations to the consortium as to how to improve the media's coverage of hazards and global change issues. If students so choose, they may attach an appendix of short, telling text excerpts or graphics that they think demonstrate well a problem of reporting that they point out to the consortium.

When students hand in their reports, ask them to summarize orally some of their findings and -- by listening to other students' summaries -- to compare how the news media differ in terms of hazard/global change reporting. Aim to draw out some generalities about what types of issues seem to be reported locally, what items make it on the national or even international agendas, how the coverage varies depending on the type of hazard, the location of the event, the political bias of the reporting source, how graphics of various sorts influence the report, and what roles reporters, editors, citizen groups, governmental agencies, and certain individuals play (individual community members, national celebrities, etc.) in determining what gets and doesn't get reported.

**Alternative Activity**

Rather than assigning this activity in any one two-week period, you may want to take advantage of a specific recent disaster or hazard that has been in the news. Adapt the activity by asking students to focus on that one disaster and to examine various printed media (plus recall TV and radio coverage) to see how they dealt with the event. If you focus on a relatively local event, discuss why or why not the event made it into the supra-regional media.

## Activity 2.4 Insured Until Death Do Us Part...

### Goals

Students get a sense for the difficult economic, ethical, and political choices insurers have to make in a world that witnesses increasing numbers of devastating hazard events. The activity is specific to climate change issues only. Students interpret various positions on this issue and try to find a consensus on how the insurance industry should deal with global change and growing losses from disasters.

### Skills

- ✔ text comprehension and critical interpretation
- ✔ forming and defending one's own opinion
- ✔ debating controversial issues in a fair and respectful manner
- ✔ weighing economic, ethical, and political factors in discussions and decisions

### Material Requirements

- *Student Worksheet 2.4* (provided)
- *Supporting Material 2.4* (provided)
- Suggested Reading: Flavin (1994) (provided)

### Time Requirements

1 hour of preparation for students before the class session
35 minutes for the role play/discussion in class

### Tasks

Students stage a Board of Directors meeting of representatives from various life and property insurance companies with significant coverage of populations in hazard-prone areas (restricted in this activity to the developed world). In this role play, students carry out the debate over how the insurance industry should deal with the increasing industry losses of recent years from weather-related multi-billion dollar disasters.

Ask students to read and understand *Supporting Material 2.4* and the suggested reading by Flavin (1994) before the next class session. You may suggest to students that they get together in pairs to work through and discuss this material. Tell students to be prepared to take various positions on the subject matter, such as:

- defending the idea to cease insurance coverage in hazardous areas;
- maintaining coverage but increasing rates;
- reducing the maximum level of coverage;
- using the insurance industry's economic strength to push for greenhouse gas emission reduction policies, building code implementation, and similar policies;

Ask students to find their preferred position on these difficult issues and to be ready to explain why they feel that way. Encourage students to think of yet alternative options the insurance industry could choose to respond to increasing losses and a changing world.

In the class session in which the Board of Directors meeting takes place, divide the class into groups of about five students each. Each group has its own meeting of insurance executives (you may assign different companies to them to add flavor, e.g., Munich Re, Swiss Re, Reinsurance Association of America, Aetna Life, Allstate, State Farm, General Accident, Sumitomo Marine & Fire). In addition, assign one of the following roles to the students in each group: **note-taker** (keeps track of the discussions), **facilitator/discussion leader** (makes sure that the discussions are orderly), **process observer** (assesses the dynamics of the debate and reflects on whether all participants were equally involved in the discussion and treated fairly despite contrary opinions), **spokesperson** (reports some conclusions and main points of contention to the class after the debate).

Students will act as insurance company executives who are well informed about global change matters and who came together to **find a consensus position** on how to deal with the increasing losses that the insurance industry has suffered over the past decade or so. Thus, everyone in each Board of Director meeting group should have a chance to state her/his own opinion, and there should be time to raise the "if's and but's" about each position represented in the group. Near the end of the debate, the group should attempt to find common ground. If it can't arrive at a consensus, students should be able to state what the main obstacles were.

The discussion should take about 15 minutes, followed by short summary reports from each group through each group's spokesperson. During the discussions, the instructor goes from group to group listening in on the discussions, playing devil's advocate if necessary by throwing provocative statements into the meeting if it appears that the group agrees too easily. After each group has reported to the class, the instructor summarizes the consensus positions and main points of contention.

# 2 Are Things Getting Better Or Worse?

## Student Worksheet 2.1

### Activity 2.1 Trends of Individual Hazards

In this activity, you will look at trends in hazard occurrences and link them to global changes. In studying the transformation of the earth, five specific dimensions are useful in describing global environmental change. These include

- the seriousness of the changes -- **magnitude**;
- the speed of changes occurring -- **rate**;
- the location and spread of occurrence -- **patterns**;
- the way they come about -- **processes**; and
- the reasons they happen -- **causes**.

In this assignment, you will examine the first three dimensions -- magnitude, rate, and pattern. Before we go into the details of what to do, let's first cover the logistics: you will most likely work on this activity in groups of 3-4, and you will either decide on a type of hazard or you will be assigned to one. Compile data on your type of hazard from Internet and World Wide Web sources. You will be able to find data in some of the on-line sources listed in the *Appendix A: Selected Internet/WWW Hazards Sites*, but feel free to explore additional Web sites that might be pertinent to your hazard trend analysis. Another good starting point is the hazard site of the *Virtual Library* which you can find at

http://life.csu.edu.au/hazards/library.html

If you are not familiar with "Web surfing," team up with one of your classmates who has already worked on the Web for a basic introduction to how to do Internet searches. You will pick up on it very quickly as you practice during this activity.

For the activity, you will conduct a kind of time-series analysis on your chosen hazard over at least 30 years (or the longest possible period for which you can find comparable data) to see whether there have been any changes in the magnitude, rate, or geographic pattern of its occurrence. Follow the steps below:

1. Produce a **chart** (or time line) illustrating the global trend in the occurrence of the hazard. For this time line, you may want to plot the annual frequency of your hazard over the study period (a blank time line is provided for you on the next page). Alternatively, or in addition (as it may provide very useful information), you may also plot annual losses (lives, damages, etc.).

2. Examine the **magnitude** of change at the global level over the selected period. To do so, calculate the difference between the first and last year of your study period; you may also express this change in magnitude as a percentage of the initial year's value, i.e.,

$$\frac{\text{(value for last yr.) - (value for first yr.)}}{\text{(value of first year)}} \times 100 = \%\text{ change over study period}$$

3. Examine the **rate** of change at the global level over the selected study period. This can be done qualitatively by simply describing what the time line looks like. Is there a steady or discontinuous upward or downward trend? Is the change obvious throughout the study period or does it start at a particular point in time? Is the trend steep or flat (which would indicate either fast or slow change)? In addition, the rate of change can be calculated. To do so, divide the study period into 3-, 5-, and 10-year periods, and calculate the change in magnitude for each period. See whether the rate changed over the course of time. You can then average the change in magnitude for each 3-, 5-, and 10-year period. The resulting number will allow you to indicate the rate of change as a fraction:

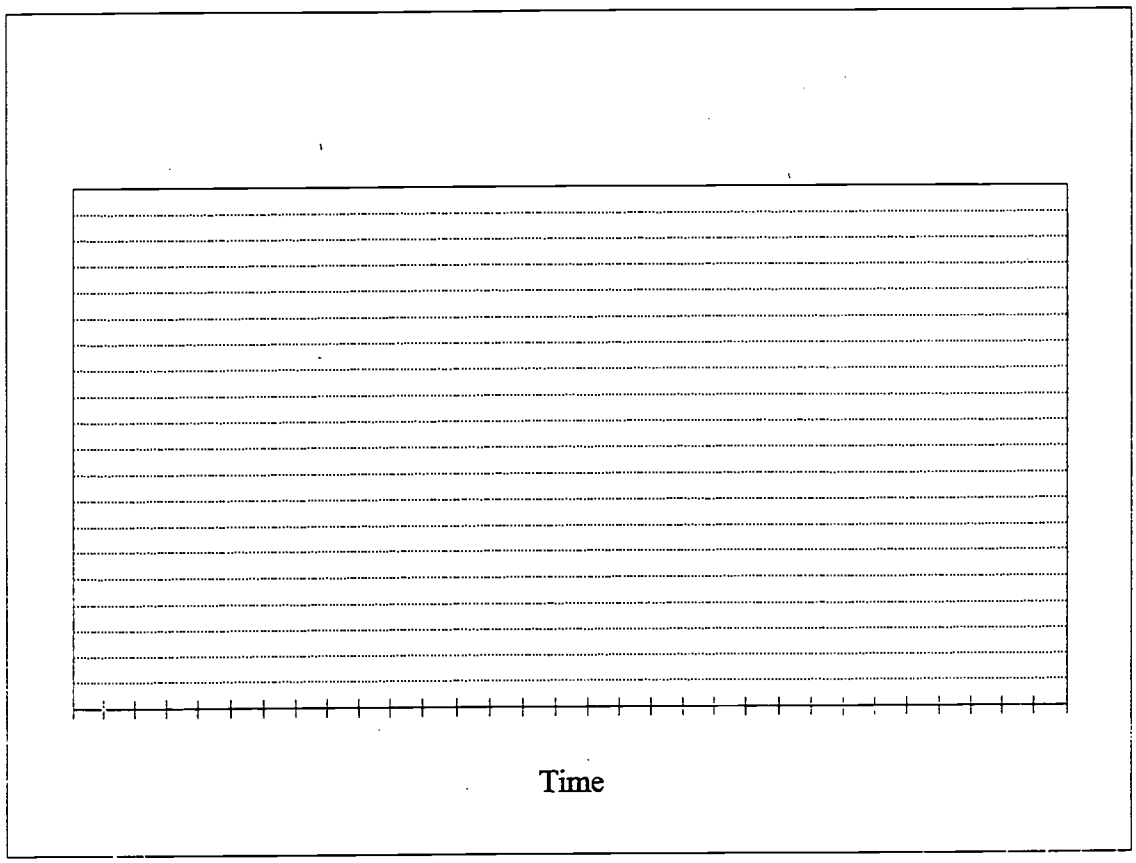
$$\frac{\text{(avg. change in magnitude for every } x\text{-year period)}}{(x \text{ years})} = \text{avg. rate of change/ every } x\text{-years}$$

4. Now, examine **regional variations** in the hazard to see if the changes are consistent in all areas, or whether there are some regions that are experiencing greater or lesser degrees of change. Do this by going through steps 1-3 for various regions, then compare what you find.

5. Use a blank base **map** of the world (or of the region you focused on) and map what you found in terms of frequency, magnitude, rate of change and regional patterns.

6. Your **final report** should include the results of all of the above steps and should provide some speculation about the processes and causes of global change that may be influencing the trends in your hazard.

## Figure 2: Change in Hazard Occurrence



# Student Worksheet 2.2

**Activity 2.2 How Vulnerable is Your Community?**

In this activity you will bring the concept of vulnerability closer to home by assessing how vulnerable your community is to one particular hazard. Specifically, you will look at what factors contribute to your community's vulnerability. For this purpose, you or your instructor will choose one hazard to focus on. The activity will be done in class and in groups outside of the classroom.

First, take a few minutes in class to write down some of the factors you believe contribute to a community's vulnerability to the hazard you have chosen. "Community" could mean your entire town or a particular neighborhood in the city. Make sure you and your instructor mean the same thing by that term.

Your instructor will collect all of your ideas on an overhead transparency and group the factors you mention into categories, such as **environmental**, **socioeconomic**, **demographic**, **technological/structural**, and **institutional/management** factors etc. Each of these categories of factors plays a part in making your community more or less vulnerable to this hazard.

Your task outside of class is to investigate the **actual situation** of these factors in your community (more on what to look for later). Actually, you will only have to look at one particular factor group. Your instructor will assign you to a group of students with whom you will work on this portion of the activity. Before you leave class, you should know in which order the groups are going to report on their findings to the class. You need to know this in order to think about how the factors you're dealing with are linked to factors that the other groups will examine. You don't have to know the exact results of the other group to make these connections; rather, you should think logically about how a factor, say from the socioeconomic category, is connected with one in the demographic or institutional category, and so on. Table 8 below shows some examples of the types of connections you should be able to make:

## Table 8: Examples of Connections Between Factors That Affect Vulnerability

| Factor Group 1 | Factor Group 2 | Example of a Connection |
|---|---|---|
| SOCIOECONOMIC<br>Low income | INSTITUTIONAL<br>Availability of shelters | Do low-income residents have similarly easy access to shelters as higher income people (proximity, no. and quality of shelters)? |
| DEMOGRAPHIC<br>Many minorities | INSTITUTIONAL<br>Availability of hazard information | Is hazard information (how to prepare, what to do in case of emergency, etc.) available in all needed languages? |
| TECHNOLOGICAL<br>Building codes | DEMOGRAPHIC<br>Housing stock | What portion of the population lives in homes built according to building codes (compare date of instituting building codes with age of structures)? |
| ENVIRONMENTAL<br>Extent of high-hazard zone | INSTITUTIONAL<br>Preparedness | What precautions have been implemented for the high-hazard zone to prevent or contain an event? Is there an emergency plan for this area? |

When you return to class with your results, you will begin the task of creating a composite picture of community vulnerability. This composite will come about by each group reporting their findings (one of you should be the group's spokesperson) to the rest of the class. Give your report in less than 5 minutes and connect your findings to those of the group that went before yours in an additional 2 minutes. If you are in the first group reporting, lay out where you see potential connections to the other groups. If you are in a later group, tell the class where you see the connections to the findings of the previous group. Clearly, this requires that you have thought about some possible connections beforehand and that you listen closely to your classmates' reports.

To find information on each of the factor groups, you will have to consult a variety of sources, and you may not use the same ones as the other groups. Some of the information will be quantitative (i.e., numeric data displayed in tables, graphics, or maps), other information will be qualitative (simply descriptive without numeric information). Here is a list of possible information sources you might want to check out:

- Census data (demographic, socioeconomic, housing data),
- maps (geophysical, floodplain, insurance rates, land use, etc.),
- Internet (city home pages, state and federal agency home pages),

- flyers from various agencies (state emergency center, department of the environment, Geological Survey, Red Cross, city government offices, fire department, etc.),
- direct inquiries (by phone or in person) at the above institutions or companies (those that pose risks in particular).

As you gathered your information, did you have any difficulties? Are there any problems with the data? Are the data at the scale and resolution you want? How up-to-date are the data? How accurate do you feel they are? Try your best, but don't get discouraged if you have trouble finding the data. This is not primarily about data or number crunching. Instead, all groups put together the vulnerability mosaic, try to get a sense of how vulnerable your community is to the hazard you have chosen. Does this help you see more clearly why it's helpful to look at vulnerability? Do you start getting a sense for what needs to happen in order to reduce losses from this hazard? Can you see how all these factors are connected and matter (albeit to varying degrees) in determining what could happen in your community?

# Student Worksheet 2.3

## Activity 2.3 The Hazards-Global Change Journal

You have been hired as a consultant by a news media consortium to give some critical feedback on the consortium's members' reporting of hazards and global change. The consortium is made up of all kinds of media who report to various audiences, and it is interested to know how well its members are reporting these issues and how they can improve on the coverage if necessary. They have asked you to report to them in about two and a half weeks. To prepare the report, you will maintain a "hazards-global change journal" for about two weeks to get a good sample of the reporting. You will track and take notes on how hazards and global change and the links between the two are reported in various news media. You and your classmates will look at **different types** of media, at media that report at **different scales**, e.g., comparing a local, national, and international paper, and at the **various means** used to report these issues (words, graphics, maps, live reports, etc.).

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Hardly a week goes by without some hazard becoming public somewhere in the world. Whether you hear about it, how much you hear, and how the events are reported and explained, however, depends on a range of factors. Investigating these factors is what your job is all about. For example,

**What** did you hear about?
**Where** did you hear about it?
**How** was it reported?
**Who** is affected and who is responsible?
**Why** did it happen?

You either choose which type of media to focus on, or you will be assigned to one. Each student is a consultant, but you split up the task, focusing on different type of media each, and each preparing a report for the Consortium. (If your class is big, you may work with several of your classmates on the same type of media.) It'll be fun and interesting to see later on how the news media compare in terms of hazard/global change reporting. All of you, however, will look at the news with the above questions in mind.

Below is a specific list of items you may want to look for as you follow the news for the next few weeks. Take notes on the reporting **every day** or else you won't recall the details. If you can, cut out newspaper articles, make copies, or record or videotape items.

- How many stories related to hazards and global change did I hear today (itemize them)?
- What happened in each event according to the news I focused on (short summary for yourself)? Was information given in later reports significantly different from that given early on in the news coverage?

- Where and when did the event occur?
- How much space was allocated to each report (columns/lines or time on the radio/TV)? How did the space allocation change over time? Did several events "compete" for space?
- Did the report include any maps, graphics, photographs, live reports, interviews with victims or witnesses? What did these items highlight about the events?
- Who reported (author, press source, speakers...)?
- If the hazard was a "natural" hazard, was any connection made to global change? Do you feel it was correct, insufficient, or misleading in any way?
- If the hazard was a "technological" hazard, were there any indications of blame or assigning responsibility?
- What was the explanation for why the hazard occurred or for why the damage was what it was?

At the end of the two weeks, you will begin the analysis of the hazard/global change reporting. Summarize the information you gathered on each of the above questions. Did you detect any similarities in the ways hazards were reported? Did you detect any significant differences in reporting between types of hazards or in reporting between hazards that occurred in different locations of the world? Was there any kind of information about the hazards (and/or the linkage to global change) that you felt was missing, wrong (according to what you know about the hazard or location), biased in any way, particularly helpful, or surprising? What made the reporting good or bad; sufficient, not enough, or too much? How did the graphics, maps, photographs etc. influence your understanding and interpretation of the event? And finally, what would you recommend to the consortium as to how to improve their coverage of hazards and global change issues? (You may want to think of what the roles of the media are in society, and how well they perform these roles.)

Your report should not exceed five pages. If you choose, you may attach an appendix of short, telling text excerpts or graphics that you think demonstrate well a problem of reporting that you point out to the consortium.

# Student Worksheet 2.4

**Activity 2.4 Insured Until Death Do Us Part...**

In this activity you will assume the role of a representative of a life and property insurance company who comes together with other representatives in a Board of Directors meeting to discuss how the insurance industry should deal with the increasing industry losses of recent years incurred by multi-billion dollar disasters. Each of the insurance companies represented writes a significant number of policies for people in hazard-prone areas (restricted here to the developed world).

Before class, prepare for the discussion by working through *Supporting Material 2.4* and the article provided by your instructor (alone or with another student). By discussing the various positions reflected in that material, you will best be able to take various positions on the subject matter, such as:

- defending the idea to cease insurance coverage in hazardous areas;
- maintaining coverage but increasing rates;
- reducing the maximum level of coverage;
- using the insurance industry's economic strength to push for greenhouse gas emission reduction policies, building code implementation, and similar policies;

What is your preferred position on these difficult issues? Why do you feel this way? Can you think of other options the insurance industry could pursue in responding to increasing losses and a changing world? Be ready to argue on behalf of a variety of positions.

In the class session in which the Board of Directors meeting takes place, you will split into several groups of about five students each. Each group has their own meeting of insurance executives (you may choose to represent one of the following companies, e.g., Munich Re, Swiss Re, Reinsurance Association of America, Aetna Life, Allstate, State Farm, General Accident, Sumitomo Marine & Fire). You will also be assigned one of the following roles during the discussion: **note-taker** (keeps track of the discussions), **facilitator/discussion leader** (makes sure that the discussions are orderly), **process observer** (assesses the dynamics of the debate and reflects on whether all participants were equally involved in the discussion and treated fairly despite contrary opinions), **spokesperson** (reports some conclusions and main points of contention to the class after the debate).

Now imagine that you are an insurance company executive who is well informed about global change matters and who has come together here with her/his colleagues to **find a consensus position** on how to deal with the increasing losses the insurance industry has suffered over the past decade or so. Everyone in your group will have a chance to state her/his own opinion; then there should be time to raise the "if's and but's" about each position represented in the group, and toward the end of the debate, you should -- if possible -- find common ground in your group. If you can't find such a position, what are the main obstacles?

# 2 Are Things Getting Better Or Worse?

## Answers to Activities

### Activity 2.1 Trends of Individual Hazards

Not all hazards that students choose will have frequency or magnitude data that can be graphed (or graphed easily) even if they find much descriptive and explanatory information on these hazards. Students will encounter first hand the data problems that hazards and global change researchers often are confronted with. Data might be missing all together, might be there only for recent years, or might not be comparable over time and space.

The trends students find depends on the type of hazard, the data sources they consult, and the changes over time that have in fact occurred with any given hazard. Similarly, their explanations are limited by these same data issues.

One example that illustrates both wealth and difficulties with data can be found on the following Emerging Infectious Disease Web site: http://www.cdc.gov/ncidod/EID/vol2no1/ and subsequent volumes and issues (the material is not reproduced here for lack of space and because of copyright restrictions). This particular Web site describes and discusses the emergence of Dengue Fever and other infectious diseases, includes maps of Dengue Fever distribution, and a table of Dengue Fever virus serotypes isolated between 1982 and 1995. Students can find additional information at the World Health Organization's Web site where they can search for Dengue Fever (the EID site is connected to the WHO homepage through a hot link).

### Activity 2.2 How Vulnerable is Your Community?

The answers to this activity depend entirely on the community and hazard that is chosen for this activity. To assess students' work, however, consider the following issues:

- familiarity with the concept of vulnerability
- ability to list a range of factors that contribute to vulnerability
- acquisition of a range of data from various sources
- good synthesis and reporting of findings to the class

- ability to make connections to other groups (integrate their knowledge with that of others)
- critical understanding of the importance of vulnerability for hazard management

## Activity 2.3 The Hazards-Global Change Journal

Students' findings on their assigned news media and their conclusions from the analysis of their journal entries will depend on the time when this activity is conducted (i.e., what hazards and global change issues are in the news at the time). Several points can be highlighted, however, as you can expect students to draw out basic generalities about reporting and the media's role in informing the public.

Below are the questions posed to students in the activity and some of the generalities that could be made.

- **How many stories related to hazards and global change did I hear today (itemize them)?**

The number of reports reflects *seasonality* of hazards (e.g., in the summer you are more likely to hear about hurricane, tropical storm, drought, tornado, hailstorm, and heat hazards), the *magnitude* ("objective" measure) and *intensity* ("subjective," human-felt experience) of the event (the bigger the event, the more often it will be in the news), *geographic proximity* to the event (as indicative of the likelihood to be affected), and the *reporting source's mission* and its *editors' political interest* in the event.

- **What happened in each event according to the news I focused on (short summary for yourself)? Were initial reports changed significantly later on?**

It is likely that big events that remain in the news for several days or longer and social hazard events (acts of war, sabotage, terrorism, interpersonal violence etc.) are followed closely and change in content over time. The higher the degree of initial confusion, the larger the secrecy surrounding the event; the more difficult to obtain accurate information, the greater the likelihood that the reporting will change significantly over time.

- **Where and when did the event occur?**

Students will notice the "home-bias," i.e., the large majority of reports on local, regional, and national events depending on the scale of the news medium they focus on. Local papers will highlight local hazards, national news will emphasize nationally significant issues. It is likely that students will find very little information in US news sources on far-away, pervasive, and

long-term issues (e.g., droughts, famines, or sudden-onset events like earthquakes in Third World countries).

- **How much space was allocated to each report (columns/lines or time on the radio/TV)? How did the space allocation change over time? Did several events "compete" for space?**

The amount of space allocated to the reports is influenced by the same factors as how much is reported: *magnitude*, *intensity*, *likelihood of being affected*, *home-bias*, and *editorial issues* like mission of information source, political bias, perceived interest in the issue, competition with other news items, etc. Students will notice a steep decline in reporting frequency and space allocation if the event stays in the news over several days at all. Items quickly drop from being of national interest to being a regional or local issue. This change in "news-worthiness" is also very much influenced by competing items. Interest in a major hurricane and its aftermath, for example, drops quickly if only three days later an airplane crashes that leaves hundreds dead.

- **Did the report include any maps, graphics, photographs, live reports, interviews with victims or witnesses? What did these items highlight about the events?**

If the event is horrific enough in the eyes of the news editors, it is likely that reporters are sent to the site of the event to gather first-hand information, make live reports, gather interviews, and take photographs. Maps are common for major events in remote locations, for hazards involving conflicting parties (e.g., war) -- refer to the vast literature on how maps express bias in reporting, or in combination with animation to reconstruct the hazard event.

- **Who reported (author, press source, speakers...)?**

It is unlikely that students will follow up on who-is-who, i.e., the background of reporting sources, or that they will -- in just two weeks -- get a sense for who reports on what. You may want to point out to them, however, that reporters, certain individuals, or citizen groups commonly have their "specialties," i.e., which issues they watch out for and report on.

- **Was any connection made to global change? Do you feel it was correct, insufficient, or misleading in any way?**

This will be one of the most interesting things for students to consider. Weather-related hazards may be increasingly connected to global climate change. Other hazards may not be linked to global changes in both society and the environment. Given the generally insufficient understanding of global change issues in the US population at large, it is likely that reports are oversimplified, undifferentiated as to the range of contributing causes and complex interactions among societal, environmental, and technological issues, and thus not very educational.

- **If the hazard was a "technological" hazard, were there any indications of blame or assigning responsibility?**

There is a tendency to assign responsibility for an environmental event. It is part of the need to find explanations for the pain people experience and to re-establish mental order in a significantly upset world. Rarely are people ready to take on their share of responsibility for the losses incurred at the time of the event; thus blame of others is common. Also particularly with some environmental disasters, the opportunity presents itself to those affected to vent long-standing frustrations.

- **What was the explanation for why the hazard occurred or for why the damage was what it was?**

This will be an opportunity for students to show that they understood the complex nature of hazards as resulting from the interactions of society, technology, and the environment. Look for their critique of the rather mono-causal or simplified explanations often offered in the news.

- **Any recommendations to improve reporting?**

Students' answers here will show how well they are able to draw conclusions from their critical analysis. Students may gear their answers to the roles that news media play in society: watchdog, gatekeeper, informer, educator, and also connector among various communities (within and between local communities across the globe). They may summarize from their analysis how well the media perform these roles and what they would need to do to perform better. Again, the specifics depend on the type of media they focus on.

## Activity 2.4 Insured Until Death Do Us Part...

The conclusions that students reach in their role play will depend on the students' values, their interpretation of the provided material, and the group's ability to find a consensus. You may help students get beyond some of the impasses or dilemmas they are likely to encounter, but it is not necessary to force them to adopt a particular view on the role of the insurance industry in global change issues. It is more important for them to see the crucial importance of insurance in determining impacts of hazards and -- possibly -- global change, and to see the insurance position from various perspectives. Students should also come away with an appreciation of the economic power that the insurance industry has in the global economy.

The activity is a nice way to end this unit and lead into Unit 3 which goes into mitigation measures in greater detail. As is pointed out in Unit 3, insurance can help to share the losses incurred by disasters. In addition, *Supporting Material 2.4* points to the mitigative, if not preventive, role the insurance industry could play if it so chooses.

# 3 How Do Societies Respond and Adjust to Environmental Hazards?

## Background Information

### Introduction

Given the enormous complexity of nature-society-technology interactions and the rather bleak trends in both disaster occurrence and societal vulnerability to hazards that we have discussed so far, shouldn't we simply "throw in the towel" and let nature and societal developments take their course? To us as individuals, things often seem to be getting worse and worse, and we don't seem to be able to put the brakes on these global physical and social processes anyway.

It would be a sad outcome, indeed, if we ended this module on such a pessimistic, even fatalistic, note. Such an attitude would dismiss entirely the fact that throughout human history, societies the world over have shown great ingenuity in adapting to their environments. It would also overlook the reality that humans are active creators of, and collaborators in, their living circumstances. We have contributed to the hazardousness of our environments as well as to the many efforts at maintaining and increasing our safety: we have workplace safety standards; we have structural and non-structural tools to protect ourselves from floods; we continue to improve our ability to forecast and warn of approaching hazards like tropical storms, earthquakes, and volcanic eruptions; we have emergency response institutions; we have public and private insurance; and the idea of preventing environmental harm (the precautionary principle) is becoming increasingly widespread as the yet-unknown impacts of global climate change loom on future's horizon.

Clearly, we have a long way to go if we want to reverse current disaster and vulnerability trends. In particular, we will have to spread our successes in mitigation much more evenly within and among nations. Some people hope that the IDNDR, along with the threat of global change, may actually translate into a strong momentum to improve disaster mitigation. Using that stimulation ourselves, we focus in this last unit on the basic question of what can be done to respond to and mitigate hazards, global environmental and societal changes notwithstanding. We begin in the first section with a look at the different phases of responding and adjusting to hazard events. The next three sections then discuss in greater detail the three fundamental ways of reducing the impacts from disasters -- modifying the hazard, reducing human vulnerability to them, and sharing the losses. Just as people perceive and experience hazards differently, we must

also discriminate among people in their ability to adjust to hazards. In the final section, we will see again that in this complex interplay of humans and their natural environment there are no simple answers to the question of how best to respond to hazards and lessen their impacts.

## Societal Response and Adjustments

The study of societal responses to hazards ranges from *what* people do in the immediate aftermath of an event and in the long term, to *how*, *when*, and *why* they respond. Response can also be more narrowly defined to mean just the immediate action after a disaster (as is done below). The following discussions are primarily about the "what and when," focussing on emergency response and long-term mitigation. Interesting work at the hazards/global change interface on societal learning, delayed and foregone responses, and responses to creeping/chronic hazards is not discussed here but ultimately contributes to a fuller understanding of effective societal adjustments to hazards.

When a disaster strikes, the immediate societal adjustments are to rescue the survivors and re-establish the lifelines (water, electricity, sewage, communication) to the ravaged community. These relief operations include medical supplies, food, shelter, water, and power. Often, such emergency **response** and relief operations are within the capabilities of the affected country. In some instances, however, the disaster is too large for the individual country and international relief efforts are mobilized by relief organizations such as the Red Cross/Red Crescent and through cooperative arrangements within the United Nations (U.N. Disaster Relief Organization or UNDRO).

Once the lifelines are re-established and the crisis period is over, the **recovery** phase begins. Recovery adjustments (like sheltering, clean-up, repairs, treating injuries, assuring order and safety from criminal behavior during emergency situations) are temporary in nature and provide for a return to normalcy after an event. The use of temporary shelters during the recovery period gives way to building permanent structures during the reconstruction phase. Throughout the recovery and reconstruction phases, hazard mitigation continues. (*Focus Issue 6* describes this phase eloquently.)

**Mitigation** is a general term used to describe a wide range of methods for disaster loss reduction that goes on before, during, and after a disaster. Some mitigation options are structural, meaning they affect the material construction or organization of something (e.g., the use of steel-reinforced construction materials in seismic areas or the use of elevated pilings in flood-prone areas). Other mitigation strategies are non-structural and involve land use planning and management, insurance, and pre-event **preparedness** (the establishment or reinstallation of warning systems).

## Focus Issue 6: An Earthquake Strikes Campus!

*On the morning of January 17, 1994, a magnitude 6.7 earthquake struck the Los Angeles area. The quake was centered near the city of Northridge. The Northridge campus of California State University sustained $350 million in damages. Every major building on campus was closed. Many buildings, including the library, were extensively damaged. A campus parking garage collapsed. The central core of the campus was virtually shut down by the quake. Ann Dittmer -- a geography graduate student at CSU Northridge-- spent the month following the earthquake caring for her mother who had broken her hip in the quake. When the school reopened in February she returned to campus and was shocked and amazed by what she found. Here is her report.*

I knew things were different when the normally bustling student parking lot was not full. I soon discovered that much of the campus had moved to the northern boundary of the college. The athletic fields and parking lots were converted to temporary campus headquarters housed in large white tents and classroom trailers. Many trailers had been set up to begin classes, yet many class groups were left homeless. For those with designated places to go, maps helped a little. Information booths were set up to help students find their classes, but often the people staffing the booths were as confused as the students. Some instructors held up signs trying to corral their lost students. Many trailers had no identification on them. The din of construction equipment added to the confusion.

It was both reassuring and disconcerting to find the geography department in a parking lot. We had no tent or trailer. One professor's blue van served as the makeshift command center. A hand-written sign claiming geography's territory was taped onto the side of the vehicle. Classes were held under trees, on parking lot asphalt, or canceled altogether. Classrooms and departments moved constantly, giving the campus a nomadic feeling. The geography department van disappeared for a week, moved to the east side of campus, and finally returned to its original spot.

The shuffling of classrooms and departments was both overwhelming and exciting. Students and professors showed incredible resilience and adaptability under those stressful conditions. A climatology lab was relocated to a professor's living room. An Internet class was forced to work without computers for half the semester. There were no maps available for the map interpretation class. The library was closed and students had to use libraries at other campuses in Los Angeles and Santa Barbara. Without central meeting areas, students who had before studied and socialized on campus now came on campus for classes and left. Later in the semester we were allowed back into our building to use the computers. The hallways were sealed off and thin blue chalk lines marked where X-rays had been taken to check the building's internal structure for damage. The exposed cracks in the plaster walls reminded me of the nursery rhyme, Humpty Dumpty.

Many memories of the earthquake's impact on the CSU, Northridge campus linger in my mind: the heat of the trailers before air conditioning arrived; the rain that turned fields into seas of mud; the constant drone of generators used to power the campus; the loss of Spring Break; the maze of raised plywood walkways that connected what seemed to be acres of trailers.

Since the Spring of 1994 the campus has slowly begun to return to normal, but some departments and classes are still housed in trailers. Several major buildings are still closed, and the collapsed parking garage is now a grassy field. Some offices, personnel, and students are still displaced, but the campus has settled into a routine, working and studying around the inconveniences. It was devastating to have the campus torn apart by an earthquake, but it was inspiring to see the way students, faculty, and administrators responded to the crisis.

There are three main avenues for reducing losses from environmental hazards. These are broadly defined as *modifying the hazard event*, *reducing human vulnerability*, and *sharing the losses*. Depending on the hazard, any or all of these loss reduction strategies may be employed. In the following three sections we will look at each of these.

## Modifying the Hazard

Modifying the hazard itself is the most problematic strategy for hazards loss reduction because we ultimately cannot control the physical forces of nature, although many societies have tried (and continue to try). Building dikes and seawalls to hold back the sea as the Dutch have done works for a limited time but in many cases has caused detrimental effects down-drift from the dike or seawall, actually aggravating the processes that such measures were meant to stop (i.e., beach erosion, flooding, and storm surges). If sea levels rise as a consequence of global warming, these dikes may also not be high enough to hold back the sea in future years. Beach nourishment (i.e., sand replenishment) is often used to maintain beaches along the US east coast, but beach erosion is commonplace and no matter how much sand is placed on the beach, it will eventually be lost. Under current projections of climate change, rising sea levels will accelerate coastal erosion.

Other hazard modification schemes have been attempted with more or (all too often) less success. These include cloud seeding experiments in the 1950s and 1960s to prevent the development of extreme low-pressure systems that cause high winds, severe downpours, and hail; flood abatement and diversion strategies; manipulation of surface and groundwater to induce small-scale seismic events to prevent the build-up of large physical strain, or to reduce frictional resistance within rocks in seismic zones; cooling, barring, or diverting of lava flows; and excavations, mass fillings, and drainage of soils and rocky substrates to prevent mass movements (selected from Smith 1992). Large-scale geo-engineering projects -- viewed by some as rather fantastic ideas -- have been proposed recently in the context of mitigation strategies for global climate change. These include replenishment of stratospheric ozone by shooting ozone into the stratosphere and the construction of huge space mirrors to reflect solar radiation back into space, thereby reducing solar input to the atmosphere and thus the warming of global temperatures.

For hazards originating in social and technological systems, the obvious strategies to reduce such threats in the first place are conflict resolution, ensuring social equity, improving on the safety of technologies or their usage, or doing without a product that has potentially hazardous effects. Not exclusively, but often with reference to technological hazards management systems, this type of modification is known as **prevention**. There are a number of ways to accomplish this, such as modifying the technology, preventing initiating events, or preventing outcomes. Modifying the technology could include a ban on the use a particular product (e.g., chlorofluorocarbons, or CFCs, which are suspected carcinogens and destroy stratospheric ozone). Preventing initiating events normally involves the use of redundant safety systems such as the secondary cooling systems found in most nuclear power plants. Even the best designed

systems fail, however, as happened with the nuclear power plant at Three Mile Island, Pennsylvania, in 1979. Preventing outcomes includes a range of technological and design decisions that reduce contaminants at their point of origin such as scrubbers (which reduce the emissions of sulphur dioxide, a key contributing agent in causing acid rain) and other pollution prevention technologies.

As past experience with modifying environmental hazards has shown, the actions taken to prevent or lessen one hazard can actually create new hazards further down the line, in other geographic areas, in different ecological subsystems, or at a later point in time. Replacing certain CFCs with other CFCs and halons is an example. We do not know the environmental impacts of these replacement chemicals, but some have already proven to be even more destructive to the ozone layer than their predecessors. Along these same lines we need to ask what the environmental consequences of large-scale interventions like space mirrors would be. While a number of hazards probably can be modified and lessened without major rethinking of our interactions with nature and technology, other hazards (regardless of their origin or magnitude) may require a new ethic about living with nature and the use of technology. The past holds many lessons to remind us to be more cautious and to consider a long-term systems perspective in attempting to "manage" the environment and ourselves. For hazards originating in the social arena where preventive measures need to address conflicts, equity issues, and the allocation of rights and responsibilities, it seems we may need an even more deeply self-reflexive and cooperative spirit, something -- as we all know -- that is very hard to realize. *Focus Issue 7* illustrates for one category of hazards how we have to rethink mitigation strategies and the ways in which we interact with the natural environment.

## Reducing Human Vulnerability

Reducing human susceptibility to the adverse consequences of hazards/disasters is another way to decrease losses. This is the area where mitigation efforts are best applied. Strategies aimed at reducing vulnerability can be preventative or response-oriented, structural or nonstructural. As a preventative measure, for example, buildings can be made safer (e.g., improving engineering standards to make them more earthquake-resistant; enforcing building codes to heighten wind resistance, and elevating buildings or parts of buildings above flood stages). We can also reduce our vulnerability with non-structural pre-impact options such as emergency planning and preparedness. The development of better forecasting and warning systems drastically reduces the impact of some natural disasters on society (e.g., the losses of lives from hurricanes in the US). Combined forecasting and warning (and if necessary evacuation) systems are successful in lessening the impact of sudden onset, major life-threatening hazards such as floods, hurricanes, and tornados. We now have sophisticated radar-based forecasting systems for hurricanes and tornados that enable emergency managers to advise the public in a timely manner to get out of harm's way and/or take precautions.

Other pre-impact mitigation strategies for vulnerability reduction include land use regulations, planning, risk and hazards laws, and international treaties for hazards reduction and control (see *Focus Issue 7* for a particular type of hazard that necessitates international treaties). In the US, pre-impact mitigation strategies include measures such as zoning ordinances and setbacks in coastal areas or floodplains to prevent people from building in highly vulnerable areas near the water's edge. In the United States, risk and hazards laws are intentionally designed to prevent human exposures and harm (Kirby 1990). Provisions included in the Clean Air Act, Safe Drinking Water Act, and the Clean Water Act, among others are all considered mitigation strategies for reducing pollution impacts. Also a large number of rules overseen by the Occupational Safety and Health Administration (OSHA) and the Food and Drug Administration (FDA) are designed to ensure the safety of the workplace and the safety of food, food additives, and drugs respectively. Finally, there are quite a few international treaties for hazards reduction and control, ranging from the 1972 London Convention on Biological and Toxic Weapons to the 1989 Basel Convention on the transboundary movement of hazardous wastes to the 1992 Climate Change treaty (Cutter 1993). As many unfortunate examples of evasion of these laws by individual firms or nations indicate (Puckett 1994; Dowie 1996), legislation must be followed by compliance monitoring to ensure their effectiveness.

Response-oriented mitigation strategies to decrease human vulnerability are those that allow people to react more quickly to a disaster such that its impacts can be contained in space, time, and to a minimal number of affected sectors and populations. Regular training for emergency response personnel like fire fighters, state or federal emergency agents, Red Cross volunteers, or the US National Guard fall into this category of measures. Establishing well-coordinated emergency and evacuation plans work toward this end as well. Finally, streamlining and simplifying the bureaucratic procedures to apply for disaster assistance and low-interest loans to rebuild after a disaster have proven to be effective in helping disaster victims get on the track to recovery.

## Focus Issue 7: Unstoppable? -- The Transboundary Nature of Hazards

It is common to think of some natural hazards as being place specific -- San Francisco and earthquakes, Jamaica and hurricanes, the Phillippines and volcanoes, and so on. Technological hazards, while not unique to any one place, may still be place-based. The effects of these events and the responses to them are usually localized, although some assistance may come from international sources. Some hazards, however, defy delineation by location. Hazards, such as acid rain or the nuclear radiation emanating from a disastrous accident at Chernobyl in 1986, have initiated risks that could not be stopped at political borders and hence have come to be known as *transboundary hazards*. Central to the issue of transboundary hazards is how to handle risks that are generated at one place, but have effects felt at another (Cutter 1993).

The event at Chernobyl, Ukraine on April 25, 1986, was the worst nuclear power plant accident in history to date. More than 1,000 square miles surrounding the facility were contaminated following the explosion. The resulting radioactive fallout was spread across Europe, hundreds of miles from its source. At issue in instances like this is how people can respond to risks from areas over which they have no control (Gould 1990). The Chernobyl accident and concerns about acid rain prompted some changes in the international arena to define who is responsible and who should take steps to prevent their occurrence. Unfortunately, the vagaries associated with determining responsibility makes many cases difficult to prove.

On a larger, global scale, one can also look to ozone depletion, deforestation, and global warming as transboundary threats. The use of CFCs predominantly in the industrialized northern hemisphere caused the loss of ozone worldwide. The unbridled cutting of vast parcels of rainforests in South America and Southeast Asia (mostly for the profit of multi-national corporations and local elites in developing countries) happens at the expense of global biodiversity, climate, and, of course, local people, native groups, and a cultural heritage from which we all benefit. The threat of global warming is brought about mainly by fossil fuel use in both developing and developed nations. Because the highly industrialized nations of the North are the largest contributors to total global carbon emissions, clearly what we do *here* can and does affect others *there*.

The very nature of hazards and global environmental change requires that we pay serious attention to present and potential transboundary hazards. Global change issues such as global warming or stratospheric ozone depletion may be the largest transboundary hazards we will need to face. What they highlight -- besides the difficult scientific and legal aspects -- are most challenging ethical issues of responsibility and equity. It is through joint international efforts, using treaties as change mechanisms (which include goals, effective implementation, and enforcement mechanisms) along with local, individual diligence at creating safer environments, that transboundary issues might be resolved.

*QUESTIONS:*

- Who should be responsible for overseeing the management of transboundary hazards -- the "causing" country, the affected country/ies, both, or an unaffected third country (if available)?
- We can't turn back the clock and simply stop all the activities that carry with them transboundary hazards. But can we do something to decrease the risk from such hazards?

## Sharing the Losses

Insurance is the most widespread method of sharing the losses, especially in the United States and other developed nations. The basic idea is that many people pay a premium into a fund that will be paid out to those (presumably a smaller number of insurance holders) who have suffered losses from a disaster. Thus, many pay a comparatively small sum of money (in effect a "loss" of income) so that in the relatively unlikely case of a major loss from a hazard event, they don't have to foot a financially devastating bill alone. Yet, homeowners who could obtain hazard insurance (for example, against earthquakes) frequently refuse to purchase it because they figure the yearly cost for the insurance is significantly higher than the risk of loss (Palm 1990). Unfortunately, increasing numbers of people are proven wrong in devastating ways. In certain instances, homeowners and businesses are required by law to obtain insurance or else they are not able to develop a piece of land or to obtain a mortgage or bank loan on their property. For example, the National Flood Insurance Program requires developers to comply with certain basic building standards that are designed to reduce the risk of damage from floods and storms.

After a series of enormously expensive disasters over the past ten years in which the national and international insurance industry suffered several billion-dollar losses, the industry is now grappling with how to continue coverage in particularly vulnerable areas and how to recover past and limit future losses from disasters (Adams 1992; Blanton 1993; Coakley 1993; Greenpeace 1993; Marley 1993; Linden 1994; Navarro 1996). Insurers see the writing on the wall; the potential effects of global warming (more frequent, more intense, or more widespread storms; sea level rise; heat waves and droughts; and widespread disease) have major insurance companies convinced that global change is here (Wilford 1993; Insurance Institute for Property Loss Reduction 1994; Deering 1994; Flavin 1994; Gordes 1996). Sea level rise, for example, would alter current floodplain delineations as the inland extent and frequency of flooding are expected to change, which would in turn would affect insurance coverage and rates.

At the heart of the insurance industry's dilemma is whether to cut losses for the industry by limiting the number and extent of policies. In the case of major disasters, many insurance claims could result in the bankruptcy of the insurer, which in turn would result in losses for both the insurance industry and the individuals (with coverage on paper). Therefore, it is in the interest of both the insurers and the insured to find solutions that enable the industry to withstand the hazards posed by global change.

Economic incentives are an increasingly effective tool for managing technological risks, especially in the United States. Differential fee structures (i.e., fees for accepting locally generated versus non-locally generated waste) is one such mechanism. The intent of differential fee structures is to make it financially unattractive and thus more difficult simply to"get rid" of a hazardous material. Ultimately, this should lead to the reduction of hazardous materials *at the source*. Other economic incentives include "polluter pays" pollution prevention programs that start with the use of the private market to reduce risks. Consumer boycotts and consumer-driven

demand for "environmentally friendly" products are additional market-driven strategies for sharing losses and reducing vulnerability that work by forcing businesses to offer "greener" and safer products.

Governmental relief operations authorized by disaster declarations is another way to mobilize the disaster response community and spread the financial and logistical burden across larger budgets and a larger number of people who can lend a helping hand, thereby facilitating immediate recovery for the affected communities. Internationally, the efforts of the transnational aid community such as the Red Cross/Red Crescent Societies, Oxfam, Caritas Internationalis, Catholic Relief Services, World Council of Churches, Save the Children, UNDRO, and other agencies help share the burden of loss from the affected communities to the global community. In 1993, for example, more than US$3.2 billion was spent worldwide on humanitarian assistance by members of OECD (IFRC 1995).

Lastly, the use of the judicial system to seek monetary compensation for damages incurred from risks/hazards imposed on a person or community by others is yet another strategy for loss sharing in which "victims" are remunerated for the sins of industry or government. This, of course, assumes that all people have equal access to the judicial system and that they are treated with equal justice by arbitrating institutions, an assumption that is frequently challenged by political reality in both non-democratic and democratic societies.

## Differential Adjustments

While the range of potential adjustments to hazards has increased over time, individual access to adjustments is more restricted now than in the past as a function of social class, income, gender, and life circumstances. Increasingly, nations and societies are more polarized between rich and poor, powerful and powerless, and divided by ethnic divisions or subcultures. The split between the "haves" and the "have nots" is widening within and among nations. Ultimately, the ability to respond to environmental hazards is constrained by these divisions.

Poverty and environmental degradation are often linked in creating an impoverishment-degradation spiral (e.g., Mellor 1988; Kates and Haarmann 1992; Watts and Bohle 1993). The driving forces behind environmental degradation are development/commercialization along with population growth and poverty. Natural hazards accelerate this process by destroying development efforts, disrupting social communities, consuming enormous amounts of money otherwise available for sustainable resource use and development, and restricting the use of remaining natural resources. Socioeconomic status plays a major role in individual and group opportunities for adjustments to these deteriorating conditions and in the recovery from hazards. Poverty restricts one's ability to maintain the simplest of adjustments (e.g., protective works) because of a lack of skill and sometimes labor to undertake the improvement, a lack of needed inputs for rebuilding, or a lack of access to education and thus knowledge of public programs for recovery. Without capital or power, poor people who often live on marginal lands to begin with,

eventually get displaced from them, and begin a migratory odyssey as environmental refugees. In many countries, these refugees are mostly women and children, two subgroups who are often the least able to adjust to environmental hazards (Cutter 1995).

As discussed earlier, urbanization is one of the key processes that influence vulnerability to environmental hazards. Not only are the world's megacities becoming more populated, they are also situated in some of the most hazard-prone areas of the world -- along coastlines and in seismically active areas (Horlick-Jones 1995; Mitchell 1995; Nicholls 1995). Air pollution, toxic chemical contamination, and poor water quality add to these areas' already difficult problems (Parker and Tapsell 1995). The elderly and children are most susceptible to air pollution episodes, be they in cities in the developing or developed world. Los Angeles, Mexico City, Beijing, Seoul, and Cairo fail to meet more than half of the World Health Organization's standards for air quality. Lead contamination is on the rise in cities in the developing world as the use of motor vehicles using lead-based fuel rises (lead -free gas is often more expensive). Furthermore, gentrification of older downtown city areas (a complex process involving inner city revitalization, housing stock renovation, and a concurrent displacement of lower-income residents by higher-income people) is exposing a new group of people to lead contamination, previously associated only with poor minorities. Societal trends like these require further exploration by hazard geographers (for a summary see Table 9 below).

**Table 9: Contextual Factors Affecting Human Responses to Hazards/Disasters**

- **Population**
  - size
  - distribution
  - displacement
- **Economic Systems**
- **Cultural Values**
- **Built Environment**
  - structures
  - lifelines (transportation, utilities, communications)
- **Social Diversity**
  - age
  - race/ethnicity
  - gender
  - physical impairment
- **Political Systems**
  - participatory democracy
  - local vs. national/state control
  - regulatory regimes & frameworks
  - internal/international security

## Conclusion

Hazard reduction, as this unit has illustrated, is an achievable goal, yet at times will require profound changes in society. Table 10 lists ongoing social trends that either lessen or aggravate the impacts of hazards on society, though some of them may be seen as double-edged blessings; they can reduce or aggravate hazards, as for example, reliance on complex technological systems or migration. Strengthening the trends that lessen impacts and reversing those that aggravate them amounts to an enormous challenge. Geotechnical solutions (levees or seismic "proof" buildings) will provide some short-term relief, but may well exacerbate hazards in the future. Ultimately, nations must address why people live in hazardous environments in the first place, how they respond and adjust to environmental hazards, and what types of mitigation programs are appropriate and acceptable by the people for whom they are meant at the local and national level. Hazard reduction strategies will vary from region to region depending on the range of hazards that affect local places, people's resources and access to them, and the opportunities that exist in any one case to integrate hazard mitigation with other development and planning efforts.

**Table 10: Social Trends Affecting Environmental Risks and Hazards**

| *Lessening the Impacts* | *Aggravating the Impacts* |
|---|---|
| • improved building technology | • increased occupancy of hazard zones |
| • better detection and warning systems | • aging populations |
| • improved health care systems | • aging infrastructure |
| • improved environmental regulations | • increasing populations |
| • environmentally sound development | • urbanization |
| • better understanding of risks and hazards | • migration |
| • improved educational opportunities | • industrialization |
| | • resource exploitation |
| | • increasing poverty |
| | • reliance on complex technological systems |

Source: Adapted and extended from Showalter et al. 1993. *Natural hazard trends in the United States: A preliminary review for the 1990s.* Natural Hazards Research and Applications Information Center: University of Colorado at Boulder. ©1993 reprinted by permission of the Natural Hazards Research and Applications Center. Pamela S. Showalter, William E. Riebsame, and Mary F. Myers.

While disasters capture our immediate attention when they happen, we must understand that hazards are in fact a part of our daily lives in order for hazard management to be effective. It is not only the extreme events such as earthquakes, hurricanes, or mine explosions that we need to prepare for or avoid. We must instead take precautions from those hazards that are more prevalent, less visible, and less drastic, but still existent, hazards that we experience every day that involve the air we breathe, the water we drink, and the food we eat.

After all, what affects us daily creates the circumstances from which we face the unusual; likewise, what we do every day, creates the kinds of situations that can become so very hazardous to us. Both affect what appears to us as a hazard, how we perceive it, how vulnerable we are to the hazard, how severe the impacts of it will be, and finally how able we are to adjust to it. This brings us back to where we started: hazards don't occur in a societal vacuum, and they are never balls (dropped accidentally by God or nature) onto a level playing field.

# 3 How Do Societies Respond and Adjust to Environmental Hazards?

## Instructor's Guide to Activities

### Goal

Students learn to distinguish the fundamental ways in which societies respond and adjust to hazards. Throughout these activities, students maintain a critical awareness of the fact that, like hazard perceptions, responses are influenced by socioeconomic, cultural, personal, and environmental factors. Students also learn to appreciate the complexities, difficulties, and ethical aspects involved in reducing the impacts of hazards on society and the environment.

### Learning Outcomes

After completing the activities associated with this unit, students should:

- be aware that hazard mitigation requires group effort for solutions that benefit the greatest number of people;
- know the phases of hazard management and their overlapping, circular nature;
- recognize the randomness and uncertainty associated with many hazards;
- have a sense for the complexity of their environment and the ways that things interact to lessen or worsen hazards;
- identify and assess physical, ecological, and socioeconomic vulnerabilities to accelerated sea level rise and evaluate options to adjust to it;
- understand that no mitigation solution is universal and that solutions often need to be tailored to fit a certain location (e.g., developed world vs. underdeveloped);
- understand that nature writing may serve as a record of people's perceptions of and values regarding interactions between humans and the natural environment;
- construct support for their assertions about what constitutes a "natural" place and change; and
- have become aware of some of their own ethics regarding the environment.

### Choice of Activities

It is neither necessary nor feasible in most cases to complete all activities in each unit. Select those that are most appropriate for your classroom setting and that cover a range of activity types, skills, genres of reading materials, writing assignments, and other activity outcomes. This unit contains the following activities:

3.1 Simulation Game of Mitigation Strategies -- role play for groups of hazard managers

| | |
|---|---|
| 3.2 Literary Responses to Hazards | -- writing assignment based on field observations |
| 3.3 The Rising Challenge of the Sea | -- assessing vulnerabilities and response capacities to SLR |
| 3.4 Reacting to the Rumbles of the Earth | -- comparison of responses to hazards in different cultural geographic contexts |

## Suggested Readings

The following readings accompany the activities for this unit. Choose those readings most appropriate for the activities you select and those most adequate for the skill level of your students.

- Unit 3: *How Do Societies Respond and Adjust to Hazards?* (provided)
  The Background Information of Unit 3 that all students should read.
- Smith, Keith. 1992. Adjustment to hazard: Sharing the loss (Chapter 4) & Adjustment to hazard: Reducing the loss (Chapter 5) in: *Environmental hazards: Assessing risk and reducing disaster*, 66-100. New York: Routledge.
  Two chapters from a hazards textbook that deal exactly with the major mitigation venues this module proposes: modifying the hazard, reducing people's vulnerability to it, and sharing the losses. A clear, concise read that repeats, extends, and puts a slightly different twist on the issues raised in the Background Information.
- Mitchell, James. 1995. Coping with natural hazards and disasters in megacities: Perspectives on the twenty-first century. *GeoJournal* 37, 3; 303-311.
  The introductory article to this special issue of *GeoJournal* on hazards in megacities lays out why hazards research and hazard management efforts should increasingly focus on urban environments, especially very large cities. It also calls for an integration of hazard management efforts with sustainable urban development, thus illustrating how the creation of hazards and their mitigation are just the two sides of the same coin. A good article to pull the units of this module together.

## Activity 3.1 Simulation Game of Mitigation Strategies

### Goals

Students learn that many factors contribute to the exacerbation of hazards. They also learn that there are opportunities throughout the hazard event (before, during, and after) to make adjustments. Students can make comparisons between the fictitious scenario and the hazards their neighborhood might face.

## Skills

✔ role identification and play
✔ team work (respectful discussion, cooperation, responsible task completion and integration)
✔ handling of complex information

## Material Requirements

- *Student Worksheet 3.1* (provided)
- *Supporting Material 3.1* (provided)
- Six-sided dice

## Time Requirements

1 - 1½ class sessions (the simulation game requires approximately 50 minutes, the group discussion could be done in the following session)

## Tasks

The simulation game of mitigation strategies is designed to engage students in the various phases of the disaster response and mitigation process and to demonstrate to them the randomness and uncertainty associated with many hazard events. Both natural and technological hazards are represented. With the role of the dice, students will be confronted by a specific hazard event. Together in small groups, students work to prepare a management plan in which they consider how to (1) prepare for the hazard, (2) respond to it, (3) recover from it, and (4) mitigate its effects. Students then briefly present their management plan to the rest of the class.

The simulation activity can be structured into the three parts listed below. A detailed explanation of each part follows the outline.

**Part 1. Pre-game structure and set-up**
- 1.1 Establish team groups
- 1.2 Describe scenario
- 1.3 Assign roles

**Part 2. The Simulation**
- 2.1 Determine hazard
- 2.2 Determine management phase
- 2.3 Choose secondary hazards

**Part 3. Solutions**
- 3.1 Team presentations of strategies
- 3.2 Open class discussion

**PART 1**

**1.1 Establish team groups**

Depending on the size of your class, you can choose from a variety of options regarding team composition, scenario choice, type of hazard, and hazard management phase as to how to design this activity (many configurations are possible, and some configurations are provided below).

***Option A)*** Divide class into two equal groups. Give each the same scenario and the same hazard. Groups use all management phases.

***Option B)*** Divide class into two equal groups. Give each the same scenario, but different hazards. Groups use all management phases.

***Option C)*** Divide class into two equal groups. Give each a different scenario, but the same hazard. Groups use all management phases.

***Option D)*** Divide class into two equal groups. Give each a different scenario and a different hazard. Groups use all management phases.

***Option E)*** Divide class into four equal groups. Give each the same scenario, the same hazard, but a different management phase.

**1.2 Describe scenario**

*Supporting Material 3.1* contains two scenarios that you can use to provide the context in which the hazard event will occur. Scenario 1 is a developed world/US example; scenario 2 describes a comparable developing world situation from Ecuador. Suggest to students that they draw a sketch of the landscape that each scenario describes to help them visualize the situation they will be asked to manage.

**1.3 Assign roles**

It may be helpful for students to assign themselves roles within their group to provoke different viewpoints and solutions to the hazard they will face. One student may choose to work as the Emergency Planner, another as the Mayor, a fire chief, the police chief, and citizen leader, and so forth. The team should be reminded to integrate everyone's ideas into the final management strategy that they present to the class.

**PART 2**

**2.1 Determine the hazard**

The hazard that the group will consider is determined by the roll of a die for a total of six possible hazards situations. The following rolls are suggested:

1 = earthquake
2 = flood
3 = hurricane
4 = radiation accident
5 = chemical spill
6 = dam failure

You may select the hazard for the groups, or if each group is working on separate hazards, the groups themselves can roll for their fate. Following hazard selection, the instructor may also

choose to roll again to determine the magnitude or intensity of the event. The following rolls are suggested:

| | |
|---|---|
| For an earthquake: | 1 = 7.0 on the Richter scale[2]<br>2 = 5.0, etc. |
| For a flood: | 1, 2 = a 500-year event (worst ever seen)<br>3, 4 = a 100-year event, etc.<br>5, 6 = flooding in selected locations |
| For a hurricane: | 1 = category 5 on Saffir-Simpson scale[3]<br>2 = category 4, etc. |
| For a radiation accident:<br>(Note: no scaling implied!) | 1 = core meltdown (Chernobyl-like)<br>2 = fire in the reactor<br>3 = leak into water cooling system and release from plant<br>4 = minor leak into air<br>5 = nuclear waste transportation accident<br>6 = accident at storage facility |
| For a chemical spill: | 1 = >10,000 gallons spilled<br>2 = 5,000 - 10,000 gallons spilled, etc. |
| For a dam failure: | 1 = rapid collapse, massive water release<br>2 = rapid collapse from smaller dam/reservoir, etc. |

Lower intensity rolls are still worthwhile. A small seismic event still gets the group thinking about what could happen in the future and how they would prepare for a larger event.

Once students know their hazard and its magnitude, get their teamwork started by asking them to consider the following questions during their discussions:

- What are the immediate dangers posed by your hazard?
- What are the long-term dangers?
- What can the individual do to mitigate?
- What can the community do to mitigate?
- Are there related hazards or secondary events?

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[2]See the Background Information in Unit 1 and Table 2 for more information on the Richter scale.

[3]See the Background Information in Unit 1 and Table 4 for more information on the Saffir-Simpson hurricane scale.

### 2.2 Determine management phase(s)

In this part of the simulation, students begin to prepare their management plan. The group as a whole may work in all phases, or each group can be assigned a different phase and work on the same event. Solutions can then be discussed to create an overall mitigation strategy. Students should address the following phases in their management plan:

| | |
|---|---|
| **Preparedness** | knowing warning signs and what to do during an emergency |
| **Response** | taking appropriate actions in an emergency that protect you from harm |
| **Recovery** | taking actions after an emergency to return to your normal life and to make yourself safer |
| **Mitigation** | preventing disasters or taking actions that lessen the harmful effects of unavoidable disasters |

Effort should be made to emphasize cyclical nature and interrelatedness of all management phases.

### 2.3 Choose secondary hazards

After allowing teams to work on solutions to their hazards, the instructor may want to stop the simulation and add another dimension to the situation. Many hazards will trigger other hazards that further complicate the situation, such as a tsunami from an earthquake (see the latter part of *Supporting Material 3.1*, which is a figure of one hazard triggering an array of secondary ones; this figure may help students to think through the consequences of hazards.)

The secondary hazard will be determined through the roll of the die. The following rolls are suggested:

For an earthquake:
1 = radiation leak, compromise at nuclear facility
2 = dam failure
3 = fires
4 = landslides
5 = tsunami
6 = nothing

For a flood:
1 = disease outbreak
2 = chemical spill
3 = dam failure
4 = transportation cut
5 = radiation leak
6 = nothing

For a hurricane:
1 = chemical spill
2 = transportation cut
3 = oil tanker accident
4 = infectious disease outbreak
5 = dam failure
6 = nothing

For a radiation accident:
1 = unprecedented numbers of road accidents
2 = looting
3 = large wild fire
4 = blizzard
5 = major railroad crash
6 = nothing

For a chemical spill:
1 = flood
2 = massive landslide
3 = disease outbreak
4 = large fire at site of spill
5 = severe thunderstorms
6 = nothing

For a dam failure:
1 = contamination of drinking water
2 = transportation out
3 = infectious disease outbreak
4 = chemical spill
5 = urban riots
6 = nothing

Introducing a secondary hazard will demonstrate the complexity involved in managing hazardous situations. It is also possible for students to see how a hazard of a local nature can spread to involve others (e.g., uncontained chemical spill in one neighborhood that enters a river and affects people downstream). Students should be cautioned that these are just examples and that other compound hazards are possible, including nothing happening.

**PART 3**

**3.1 Team Presentations**

Each team presents their management plan for dealing with their particular hazard. In this plan, each team should address the questions that you asked them to consider (see above) and the appropriate management phases. Ask students also to report on the difficulties they had, if any. For example, did they need more information? Presentations should be brief and will likely move quickly into the open class discussion.

### 3.2 Open class discussion

The class discussion will most likely evolve naturally out of the presentations by the different teams. You may structure it around the following questions:

- If the same hazards were used, what differences were arrived at in the strategies?
- How are the management phases different?
- How are they related?
- Did you do anything different in your strategy based on the differences in the scenarios?
- Did you prepare for some hazards similarly? How?
- What other possible secondary hazards might arise from these primary hazards?
- What hazards do you think exist in *your* town, *your* neighborhood?

The discussion serves to summarize and pull out major conclusions on the process of mitigating and managing a variety of hazards in different geographic, socioeconomic, and cultural situations. You may choose to assign this activity for credit or bonus points or use it simply as a way to stimulate active learning and group participation.

## Activity 3.2 Nature Writing and the Changing Environment

### Goals

Students learn that nature writing may help illuminate a culture's way of living with environmental change. Students also learn that the naturalness of ecological communities can never be assumed without investigating human history. Students are asked to explore and respond not only to the natural world but also to environmental changes.

### Skills

- ✔ critical and analytic thinking
- ✔ creating a personal expression of their own perceptions and values of the natural world
- ✔ coupling observation with explanation through the formulation of geographic questions, research and analysis

### Material Requirements

- *Student Worksheet 3.2* (provided)
- *Supporting Material 3.2* (provided)
- Map of local area

### Time Requirements

1 class period (maximum) for the in-class discussion
1 week for the writing assignment

## Tasks

Brainstorm with the entire class (or in smaller groups if the class is large) to create a list of natural places that students visit or experience on a daily basis. These places might include local city or state parks, backyards, atriums, groves of trees through which students walk, arboretums, botanical gardens, the school grounds, greenbelts, fields, open lots, lakes, ponds, rivers, streams, etc. Write the suggestions on the board or on an overhead transparency.

Next, begin to ask questions of the students with reference to the list. For example:

- Where are these places? (locate on local map as a class or in individual groups)
- Are they geographically related? How? Is their a discernible pattern?
- Since when have these sites been considered "natural?"
- Has their "naturalness" changed over time? To what extent? How? Why?
- If the places changed over time, what changed them? Were the agents of change "natural" or of a different origin?
- If a hazard or global change altered these places, would it still be "natural" and would you still like it as much?
- Who decided they were "natural" places? Are all the places equally "natural?" Why or why not?
- Are all students in agreement?
- How often do students visit these places? How much time do they spend in these places when they do visit? Do they wish they could spend more time in these places? Why or why not and how come?
- Is there a general abundance or lack of places considered "natural?"

From a discussion of such questions, individual values about what people want from interactions between human and environmental systems and perceptions of individual connections between places and people should become clear. If your discussions included hazards and global change, try to relate them to students' values about the environment. It may help to restate or summarize students' viewpoints in a way that doesn't blame or ridicule them but rather helps students become conscious of their expressed values.

At this point, introduce the idea of nature writing as a cultural expression of values and perceptions of the natural environment. Survey the list of nature writers (provided in *Supporting Materials 3.2*) and bibliographic sources before class so you can select and distribute a few passages for discussion.

Use this as a lead into the nature writing assignment. Students should be asked to select a natural place from the list they created in class and write a piece on the selected place that would fall into the genre of nature writing. Allow different formats, like poetry, descriptions, of more philosophical reflections that weave together personal observation, background information of the place that they find, and deliberation of their values. To do so, recommend that students spend some time at the site about which they would like to write.
Decide upon the paper length given class size and other writing assignments that the class will do over the course of this semester.

## Activity 3.3 The Rising Challenge of the Sea

### Goals

Through the use of the Common Methodology procedure developed by the Coastal Zone Management Subgroup (CZMS) of the Intergovernmental Panel on Climate Change (IPCC), students perform a comprehensive assessment of a site's vulnerability to accelerated sea level rise (ASLR). In addition, students get a glimpse into the concerns and needs of coastal areas to address the challenges of a rise in global sea level in the future.

### Skills

- ✔ critical text comprehension
- ✔ data acquisition
- ✔ self-searching reflection about issues of control over environmental problems

### Material Requirements

- *Student Worksheet 3.3* (provided)
- *Supporting Material 3.3* (provided)
- Background reading: CZMS. 1992. *Global climate change and the rising challenge of the sea.* Report of the Coastal Zone Management Subgroup of the Response Strategies Working Group of the IPCC; Supporting document for the IPCC update report 1992. Washington, DC: NOAA.

  Request from: Lynne Mersfelder
  NOAA/NGS International Affairs Office
  1825 Connecticut Ave. NW Suite 613
  Washington, DC 20009
  **Allow sufficient time to obtain this report!**

### Tasks

In this activity students deal with two things: (1) they learn about sea level rise, the country's vulnerability to it, and the IPCC's efforts to improve vulnerability assessment aimed at identifying most appropriate response strategies; and (2) students reflect on their own notions of how much control they have over global environmental issues and "doing something about them."

The activity begins with this latter issue in the form of a general question and answer session about what physiologists call "*locus of control.*" Use the list of statements in *Supporting Material 3.3* (copy for your students as hand-outs) which is derived from an article by Smith-Sebesto on locus of control in the *Journal of Environmental Education.* Assess and prompt students to identify their own locus of control. In other words, ask students if they think they have any power to do anything that might have an effect on the outcome of an issue. Provide examples or cases with ascending degrees of "globalness" on which they might respond with a

"yes" or a "no." For example, ask questions like "Do you think you could lower your utility bill?", "Do you think you could organize a community litter pick up?", "Would it make a difference?", "Do you believe you have the power to affect how a place responds to a rise in sea level?"

At this point, explore with your students the issue of accelerated sea level rise (ASLR). A presentation of facts and figures would be appropriate. Introduce the Intergovernmental Panel on Climate Change (IPCC) and its subgroups, including the Coastal Zone Management Subgroup (CZMS). Discuss the IPCC's latest report. If you need additional information on the IPCC or its reports, consult either their publications or the excerpts from and executive summaries of the reports available on the IPCC Homepage at the following address: http://www.unep.ch/ipcc/ipcc-0.html. Topics to discuss here might include: the consensus status of the group, its credentials, its role in global politics, and its strategies for improving the assessments of vulnerability to environmental change. Round out the discussion with the idea that these are individuals acting in response to global issues. Speculate on the group's locus of control.

Then assign students or groups of students to one of the case studies contained in the IPCC's 1992 report supplement from the CZMS. Have students complete an assessment report for their country, based on the attached outline (*Vulnerability Assessment Report* and *Guide to Vulnerability Assessment Report* attached to the Student Worksheet). Students may find data within that report, from the Internet, and in libraries (statistical yearbooks, country reports, geography books about these countries, etc.). Students should be aware of the purpose of the CZMS document "to describe and analyze ongoing activities for assessing vulnerability to sea level rise and formulating potential adaptive response strategies." This part of the activity is designed to give students an overview of the issues surrounding a possible rise in sea level.

When students return with their various vulnerability assessment reports (you may ask them to write up their results or simply bring in the *Vulnerability Assessment Report* sheet), go back to one of the original questions posed in the beginning of the activity: "Do you believe you have the power to affect how a place responds to a rise in sea level?" Ask them to put themselves into the position of someone living in a coastal community in the country they investigated. Thus, students are asked to connect questions about locus of control (a person's belief system) with a critical assessment of the factors that determine a country's or community's vulnerability to sea level rise. Conclude the in-class discussion by pointing to the importance of these human dimensions (belief systems and those that affect vulnerability) when looking at the impacts of global (climate) change.

## Activity 3.4 Reacting to the Rumbles of the Earth

### Goals

Students focus on the human responses to different hazards in different cultural and geographic contexts, compare these responses, and use them as a basis for an empathetic letter to the editor assessing these responses.

### Skills

- ✔ critically assessing and comparing human responses to hazards
- ✔ working individually, in pairs, and in groups
- ✔ empathizing and relating to others in different cultural contexts
- ✔ writing an op-ed or letter to the editor

### Material Requirements

- *Student Worksheet 3.3* (provided)
- Access to a library with newspapers, weekly news magazines, scientific journals

### Time Requirements

2-3 hours outside of class to search for articles on hazards (different for each individual)
15 minutes in class
1 week to prepare the written assignment

### Tasks

**Part I**

In this activity, students investigate the responses to various hazards in different cultural and geographic contexts using reports on hazard events over the past year in newspapers, magazines, and/or scientific articles. Journals like *Environment* and *The Ecologist* are good sources because they are published frequently enough to be quite up-to-date, and are scientific, yet written in an accessible way, often emphasizing in their articles the human face of environmental issues.

Before you assign students this activity, divide the class into groups of 4 or 5 and give each group one type of hazard to focus on. Make sure to include a range of hazards, preferably some you know have occurred in culturally different locations (e.g., in the US and in Asia, in Africa and Europe, or in East and West European countries, etc). Earthquakes, floods, toxic materials or oil spills, possible volcanic eruptions, tropical cyclones (hurricane, typhoon), infectious diseases, or droughts are good suggestions for this activity as they are common throughout the world. To make things even clearer you may tell students which events to search for (i.e., if you know the dates of when they happened). Ask students to look for articles on this one type of hazard or on the two specific events of this particular type that you have singled out in two different locations. Encourage them also to check international newspapers, especially from the country in which the event occurred as they might better reflect the cultural influence on people's responses.

When students return with their news reports to the next class session, ask them to get together in their groups and share their findings with each other. The Student Worksheet contains a table that will help them organize the information and structure their analysis of these reports. Ask them to use that table as a guide along with the following questions:

**For each location:**

- Are there differences in the responses between poor vs. rich people?
- Are there differences in the responses between male vs. female inhabitants?
- Are there differences in the responses between people of different ethnic origin?
- Are there differences in the responses with regard to different levels of education?
- Are there differences in the response with regard to distance to the hazard?

**Comparing events/responses in both locations:**

- Are there differences in the responses attributable to cultural differences?
- Are there differences in the responses attributable to socioeconomic and technological ability?
- Are there any responses that strike you as surprising or extraordinary? etc.

The teamwork and in-class portion of this activity ends with students having filled out the table and reporting some of their findings to the class as a whole. Try to have students come up with some generalizations if there are any. The main point they should come away with is that human responses to hazards are an intricate combination of hazard-specificity, education, socioeconomic and technological ability, ethnicity, gender, and geography, with the relative importance of each of these factors varying from event to event.

**Part II**

Ask students individually to write an op-ed piece or a letter to the editor of a newspaper in either one of the two locations they studied. Tell them they are writing this letter from the perspective of a victim in one event (as if it had happened to them ...) but with (newspaper) knowledge of the other. For example, if they focused on the Northridge and Kobe earthquakes, a student may write as a Kobe resident to the Northridge newspaper relating his/her experiences to an audience that went through a similar hazardous event but whose responses may have been curiously different. Students should feel free to make up how they "personally" were affected by the event. Thus students get to summarize the information they collected in the comparison table and at the same time "put themselves in the shoes" of victims and of people in different cultural and geographic contexts. The op-ed letter should be no longer than two pages, and students should hand in the completed table along with the paper.

# 3 How Do Societies Respond and Adjust to Environmental Hazards?

## Student Worksheet 3.1

### Activity 3.1 Simulation Game of Mitigation Strategies

In this simulation game of mitigation strategies, you will work through the various phases of the disaster response and mitigation process and deal with the randomness and uncertainty associated with many hazard events. You will work this out in a situation described in either a US-based or an Ecuador-based scenario, and deal with both natural and technological hazards. You will work in a team with other students toward solutions that would mitigate the hazard event(s).

Hazard mitigation requires a group effort to find solutions that benefit the greatest number of people. You will find that there are management opportunities throughout the hazard event (before, during, and after) to make adjustments so as to limit its impacts. Thus, in this activity, you will get a good sense for the differences between the phases of hazard management and their overlapping, circular nature. Following the game, you will have a class discussion in which you compare the fictitious scenarios with the hazards your neighborhood might face. By the end of this activity you should have a sense for how complex your environment is and how its various aspects interact to lessen or worsen hazards (and even produce secondary hazards). You will see that mitigation strategies are not universal, but that they often need to be tailored to fit a certain location (e.g., developed world vs. underdeveloped).

Since this is a pretty lengthy activity, here is an overview of all of its parts:

**Part 1. Pre-game structure and set-up**
- 1.1 Establishment of team groups
- 1.2 Assignment of roles
- 1.3 Scenario descriptions

**Part 2. The Simulation**
- 2.1 Determination of hazard
- 2.2 Determination of management phase
- 2.3 Choice of secondary hazards

**Part 3. Solutions**
- 3.1 Team presentations of strategies
- 3.2 Open class discussion

You or your instructor will roll a die to chose the type and magnitude of the primary and secondary hazards you and your team will work with. This will demonstrate how hazards often have a quality of randomness and uncertainty associated with them. Certainly, there are also causal links between primary and secondary hazards as some of the possible choices show.

A roll of the die will decide which of the following primary hazards you will have to manage:

1 = earthquake
2 = flood
3 = hurricane
4 = radiation accident
5 = chemical spill
6 = dam failure

Each of these hazard events can occur at varying magnitudes and intensities. Another roll of the die will decide how severe an event you will have to face (severity levels differ by hazard type). The secondary hazards range from massive road accidents to landslides, to blizzards, to wild fires, to urban riots, to another hazard from the list given above (options also differ by hazard type). Roll the die a third time to determine your secondary hazard.

Your instructor will provide you with one of two scenarios (*Supporting Material 3.1*). You may find it useful to draw a sketch of the landscape the scenario describes, just to help you visualize the area you will have to manage. (Note, this is not supposed to be a piece of art or something you will be graded on, just a sketch that will assist your management task.)

Now that you have all the information on your particular hazard situation, you will get together in hazard management teams to figure out the best responses and longer-term solutions to lessen the impact of the events given your scenario. You may find it helpful to assign yourselves roles within your group to provoke different viewpoints and solutions to the crisis. For example, one of you may choose to work as the Emergency Planner, another as the Mayor, yet another as a Fire Chief, the Police Chief, and as a Citizen Leader, etc.

Here are some questions to help you get started to think about your management strategies:

- What are the immediate dangers posed by your hazard?
- What are the long-term dangers?
- What can the individual do to mitigate?
- What can the community do to mitigate?
- How would related hazards/secondary events impact your mitigation strategies?

Remember that you will have to address the four hazard mitigation phases listed below (unless each team gets to focus on a different phase) and propose solutions to lessen your hazard within each phase. Obviously phases overlap to some extent and are interrelated and cyclical. The phases are:

| | |
|---|---|
| **Preparedness** | knowing warning signs and what to do during an emergency |
| **Response** | taking appropriate actions in an emergency that protect you from harm |
| **Recovery** | what to do after an emergency to return to your normal life and to make yourself safer |
| **Mitigation** | preventing disasters or taking actions that lessen the harmful effects of unavoidable disasters |

You have about 30 to 40 minutes to work through the problem and find some solutions for each management phase. Then you will give a brief presentation that includes a short summary of the challenges you had to confront, i.e., which scenario you were working under, what your primary hazard was, its severity, and what the secondary hazard was. Then present your suggested solutions.

Once all groups have presented their mitigation strategies, you will move into an open class discussion in which you will consider the following questions:

- How are the management phases different?
- How are they related?
- Did you do anything different in your strategy based on the differences in the scenarios?
- Did you prepare for some hazards similarly? How?
- What other possible secondary hazards might arise from these primary hazards?
- What hazards do you think exist in *your* town? *your* neighborhood?

Have fun!

# Student Worksheet 3.2

**Activity 3.2 Nature Writing and the Changing Environment**

In this activity you will look at some "natural" places in and around your community and consider how they reflect what people value in the environment and how that has changed over time. You will begin the activity in class by creating a list of "natural" places around town and discussing how they've changed over time and what you like about them. In particular, try to imagine what the place would look like if a hazard of some sort affected it or how it would be different with global change. Would it still be "natural?" Would you still like it? Take notes on that discussion as it will help you with the writing assignment below.

Select and visit a local "natural" place that has some personal meaning to you. Ask yourself the following questions about this site:

- Why did you chose the particular site?
- How often do you visit this place?
- When was the last time you visited?
- Is this site related to other "natural sites?"
- Is their a discernible pattern?
- Do you consider the place "natural?" And since when has the site been considered that?
- Has the site's "naturalness" changed over time? How and why or why not?
- Who decided this was a "natural" place?
- Is the selected site more or less natural than other places in the area?

Spend some time making observations in light of theses questions, noting time and place-specific details of your visit. Be alert!

Next, using issues brought up from your site questioning, substantiate your observations, when appropriate, with published sources pertaining to the place. In other words, research the human and natural history of your site. Be thorough!

Finally, write a short paper that weaves together the observed details, histories, and personal experiences of the site. (Your instructor will tell you how long the paper should be.) You can write a poem, a descriptive account, a short story, or a more philosophical reflection. Attach of bibliography of your sources of information. Be creative!

# Student Worksheet 3.3

**Activity 3.3 The Rising Challenge of the Sea**

In this activity you will look at two issues: (1) accelerated sea level rise (one of the expected consequences of global climate change), a country's vulnerability to it, and the efforts of the International Panel on Climate Change (IPCC) to improve vulnerability assessment aimed at identifying most appropriate response strategies; and (2) your own feelings about how much control you think you have over global environmental issues and "doing something about them."

Let's begin with the second issue. In class you will take part in a general question and answer session about what physiologists call "*locus of control*," meaning who people believe has the power or control to affect environmental, social, and even personal matters. For example, if a storm strikes a community, do people believe it's an act of God (God would be the locus of control in that case), the whims of unpredictable nature, or the result of human actions. In each case the locus of control would be different, and would make a difference in terms of what people would do about such a hazard. If God is in charge, there is nothing we can do anyway....

Use the list of statements in *Supporting Material 3.3* (provided by your instructor) to identify your own locus of control. Which statements come closest to your own beliefs? Remember none of these is "better" or "worse" -- the statements are only meant to help you become conscious of your own beliefs regarding control. Do you feel you have any power to do anything that might have an effect on the outcome of an issue?

Next, you will learn about sea level rise and the work of one of the subgroups of the IPCC, the Coastal Zone Management Subgroup. Your instructor will provide you with a copy of a report this subgroup has written, *The rising challenge of the sea*. This report details a vulnerability assessment methodology that the CZMS has put together based on a wide variety of vulnerability studies done by individual researchers from all over the world.

Your assignment is to take one of the case studies contained in the CZMS's 1992 report and complete an assessment report for the country you have chosen. Use the outline on the following pages (*Vulnerability Assessment Report* and *Guide to Vulnerability Assessment Report*) to study this country's vulnerability to sea level rise more closely. Look for the necessary data within that report, on the Internet, and in libraries (statistical yearbooks, country reports, geography books about these countries, etc.). Your investigation will help you get an overview of the issues surrounding a possible rise in sea level.

When you return to class with your vulnerability assessment reports, think again about one of the original questions posed in the beginning of the activity: "Do you believe you have the power to affect how a place responds to a rise in sea level?" Put yourself into the position of someone

living in a coastal community in the country you investigated. With your consciousness of your own locus of control and your understanding of some of the factors that determine a country's or community's vulnerability to sea level rise, do you think this community or country will feel like they can influence the magnitude of impacts from sea level rise?

# Vulnerability Assessment Report

(use the Vulnerability Assessment Report Guide below to collect pertinent information)

**Study Area/ Site** _____

**Inventory of Study Area Characteristics**

-- **Physical Characteristics**

-- **Habitat and Species**

-- **Socioeconomic Information**

-- **Cultural and Historical Assets**

-- **Large-Scale Engineering Projects**

**Identification of Relevant Development Factors**

-- **Population Density**

-- **Land Use**

-- **Level of Capital Investment**

**Assessment of Physical Changes and Natural Systems Responses**

-- **Erosion/Accretion**

-- **Water Levels**

-- **Salinity Changes**

**Formulation of Response Strategies and Assessment of Their Costs and Effects**

-- Retreat? Accommodate? or Protect?

**Interpretation of Results**

-- What are the physical changes imposed by ASLR and the related socioeconomic and/or ecological impacts?

-- Are the response options feasible?

**Internal Locus of Control and Environmental Action**

-- What is your the role as an individual in the mitigation and response to global change?

## Guide to the Vulnerability Assessment Report

*(Examples of the kinds of items to collect data on are listed under each category)*

**Study Area/Site**

**Inventory of Study Area Characteristics** *collection of all relevant data*

**Physical Characteristics** *wetlands, coast types, river discharges, coastal geomorphology*

**Habitat and Species** *species with protected status, fish reproduction sites, national parks, nature reserves*

**Socioeconomic Information** *GNP, population*, etc.

**Cultural and Historical Assets** *sites with irreplaceable historic value*

**Large-Scale Engineering Projects** *seawalls, dikes, waterways*

**Identification of Relevant Development Factors**

**Population Density**: *high/low, increasing/decreasing*

**Land Use**: *agriculture, fisheries, forestry, mining, tourism, recreation, industry and ports, transportation*

**Level of Capital Investment**: *housing and urban development, commercial buildings and utilities, production facilities, infrastructure facilities*

**Assessment of Physical Changes and Natural Systems Responses**

**Erosion/Accretion:** *morphological development of the shoreline and/or flood plain*

**Water Levels**: *coastal, tidal and inland waters, groundwater systems*

**Salinity Changes**: *surface water and groundwater resources and expected changes*

**Formulation of Response Strategies and Assessment of Their Costs and Effects**

**Retreat? Accommodate? or Protect?**
*An estimate of the costs and an assessment of effects of simplified options (without protection/ with full protection) should be included. These cases might represent two extremes and might hint at a range of alternative response options.*

**Interpretation of Results/Summary**

**What are the physical changes imposed by ASLR and the related socioeconomic and/or ecological impacts?**

**Are the response options feasible?**
*Once a summary of physical changes imposed by ASLR has been presented, the feasibility of retreat, accommodation, and protection adaptive strategies should be discussed. Considerations might include: Capital value loss versus GNP of study area or nation, number of people at risk versus total number of people in study area or nation, capital value at risk versus total value in study area or nation, agricultural area affected by salinity versus total agricultural area in study area or nation, financial damages versus GNP of study area or nation, ecological area lost versus total ecological area in study area or nation, number of cultural/historical sites lost in the study area versus total number of sites.*

**Internal Locus of Control and Environmental Action**

**What is the role to the individual in the mitigation and response to global change?**

*A personal reflection on the feasibility responses should be discussed in light of what an individual might do in the face of global change. In this section you have the opportunity to address such questions as:*
*- Do the ecological practices of a person like myself influence the quality of the environment?*
*- Would the actions of local, state, or national politicians on a particular environmental issue be affected if I were to make them aware of my concerns on the issue?*
*- By prompting others into action, could I play an effective role in determining the outcome of a particular environmental issue?*

Your instructor will tell you whether to do this activity alone or in pairs or small groups, and whether you should write a short report on what you found.

# Student Worksheet 3.4

**Activity 3.4 Reacting to the Rumbles of the Earth**

In this activity, you will investigate the responses to various hazards in different cultural and geographic contexts using reports on hazard events during the past year in newspapers, magazines, and/or scientific articles. Journals like *Environment*, *The Ecologist*, and the like are good sources because they are published frequently enough to be quite up-to-date and are scientific yet written in an accessible way, often emphasizing the human face of environmental issues.

**Part I**

Your instructor will give you and a few other students one type of hazard to focus on. You may either choose which events you will focus on, or your instructor will give you some more guidance. Some of you will look at natural hazards, others at technological hazards. You will look at a hazard event that has occurred in the US and in at least one other country. Try to find reports on the event(s) in the US and in the other country. You may check national and foreign/international newspapers, especially those from the country in which the event occurred as the latter newspapers might better reflect the cultural influence on people's responses.

When you return with your news reports to the next class session, get together in your groups and share with each other what you found. On the next page you find a table that will help you organize the information you find in these articles and structure your analysis of the reports. For your analysis use the following questions as guides:

**For each location:**

- Are there difference in the responses between poor vs. rich people?
- Are there differences in the responses between male vs. female inhabitants?
- Are there differences in the responses between people of different ethnic origin?
- Are there differences in the responses with regard to different levels of education?
- Are there differences in the response with regard to distance to the hazard?

**Comparing events/responses in both locations:**

- Are there differences in the responses attributable to cultural differences?
- Are there differences in the responses attributable to levels of socioeconomic and/or technological development?
- Are there any responses that strike you as surprising or extraordinary?

Complete the table together in your group (each of you should have a completed table in the end) and report some of your findings to the class. Can you make any generalizations about the way people respond to the hazard event? Are there any distinct differences? While you may or may not be able to find such any commonalities and differences, you will see that human responses to

hazards are an intricate combination of hazard-specificity, education, levels of socioeconomic and technological development, ethnicity, gender, and geography, the relative importance of each of these factors varying from event to event.

**Part II**

Write an op-ed piece or a letter to the editor of a newspaper in either one of the two locations you studied. You will write this letter from the perspective of a victim of one event (as if it had happened to you...) but with (newspaper) knowledge of the other. For example, if you focused on the Northridge and Kobe earthquakes, you may write as a Kobe resident to the local Northridge newspaper relating your experiences to an audience that went through a similar hazardous event but whose responses may have been curiously different. You can make up how you personally were affected by the event. Use the information you collected in the comparison table, and at the same time "put yourself in the shoes" of victims and of people in different cultural and geographic contexts. The op-ed letter should be no longer than two pages. When you hand in the paper, attach your completed table to it.

**Table 11: Comparison of Responses to Hazards in Different Places**

| | Location 1 | Location 2 |
|---|---|---|
| **Event** (what/when/how/ who is affected?) | | |
| **Impacts** (how wide/how many/how expensive etc.?) | | |
| **Responses** (who is involved?) | | |
| ----- **Gender** differences? | | |
| ----- **Ethnic** differences? | | |
| ----- **Class** differences? | | |
| ----- **Education** differences? | | |
| ----- **Distance** to hazard differences? | | |
| ----- **Cultural** differences? | | |
| ----- **Socioeconomic** and **technological** differences? | | |
| ----- Anything **surprising** or **extraordinary**? | | |

# 3 How Do Societies Respond and Adjust to Environmental Hazards?

## Answers to Activities

### Activity 3.1 Simulation Game of Mitigation Strategies

The answers to this activity will depend on the scenario, hazard, severity, and secondary hazard, and of course, the students' ingenuity in finding solutions. Use the criteria below to evaluate their outcomes.

- How did students work together as a team? Were students cooperative, inclusive, and respectful?
- Did students consider all management phases?
- Were students realistic about what they proposed as solutions? A difficult issue to evaluate as "realistic" may to some mean "what we've always done." Students should not feel restricted to a minimal options-perspectives, but demonstrate awareness that certain solutions are simply not feasible, if not outright nonsensical, e.g., to move everyone out of Metropolis.
- Did students take the given scenario sufficiently into account (e.g., massive clean-up machinery may not be feasible in mountainous Ecuador)?
- Did students assess the dangers of the different hazards adequately and address each in their response strategies? For example, if students dealt with hurricanes, did they address high winds, severe downpours, flooding, the possibility of thunderstorms and tornadoes, and the storm surge?
- Did students realize, and struggle with, the complexities of the hazard management process?
- Are students able to transfer what they've done in the activity to their own community or neighborhood?

## Activity 3.2 Nature Writing and the Changing Environment

What and how students write for this assignment depends on the site they select, the observations they make, the background information sources they find and include, and the form in which they choose to relate their reflections on the site. Use the criteria below to assess their papers. See *Notes on Active Pedagogy* for additional suggestions on evaluating students' written work.

- Did the students provide a detailed and colorful account of the site?
- Is the research on the human and natural history of the site thorough?
- Is the reflection on personal responses to and ethics about the site critical, self-aware, and literarily supported?
- Is the paper well structured and creative?

## Activity 3.3 The Rising Challenge of the Sea

In the discussion and students' vulnerability reports look for the following:

- a clear effort to collect data from a variety of sources;
- a fairly coherent picture of the vulnerability of their chosen country from the data collected;
- a conscious reflection on their personal beliefs about the locus of control; and
- an awareness for the complexity of factors affecting a country's vulnerability and capacity; to respond to ASLR.

If you ask students to write up the results from the vulnerability assessment, also assess the clarity, construction, creativity, and technical appropriateness of their papers. See *Notes on Active Pedagogy* for additional suggestions on evaluating students' written work.

## Activity 3.4 Reacting to the Rumbles of the Earth

The specific answers to this activity depend on the hazards people focus on, which events they compare, and what sources they find. Some of the commonalities students might find include the following:

- impacted populations often develop a strong sense of community in the wake of a disaster (more than they typically do under non-disaster circumstances); this may be more pronounced or obvious in developed nations or in urban areas because a sense of community is still more commonplace in rural societies;

- people commonly react with more blame to technological disasters and with more helplessness or acceptance of natural disasters;
- communities/nations that are more socioeconomically and technologically developed often mobilize more quickly and efficiently; they are also more likely to decide on some large-scale, expensive, structural adjustments to hazards than poorer communities/nations;
- there may be differences in whether people feel that they can change their fate, limit future impacts, and/or lessen their vulnerability based on cultural and educational influences;
- the effectiveness of responses may differ with the presence or absence of guides, managers, and other people "in charge";
- the types of responses and personal engagement with the hazard change with the distance from the hazard (from helping in the rescue and clean-up to sending donations of money and in kind, etc);
- a surprising response to a US observer (although not, for example, to a Taiwanese observer) would be if injured disaster victims were taken to a religious leader instead of a doctor or hospital.

# Glossary

Note: Terms that appear in **bold** in the right hand column are explained elsewhere in this glossary.

| | |
|---|---|
| **areal extent** | a measure of the geographic coverage of the hazard event and the range of its potential damage; the physical space covered by a hazard event. |
| **blizzard** | winter storms characterized by low temperatures and strong winds that blow large amounts of snow; other winter storms include ice storms or snow squalls. |
| **chronic hazards** | a group of hazards that do not stem from one event but arise from continuous conditions (e.g., famine, resource degradation, pollution, and large-scale toxic contamination) which accumulate over time. |
| **cyclone** | a low-pressure system. Tropical cyclones originate in the low (tropical) latitudes and can -- under conditions of high surface temperature and moisture over the tropical oceans -- evolve into severe tropical storms or even **hurricanes**. |
| **disaster** | a singular or interactive hazard event that has a profound impact on local people or places either in terms of loss of life or injuries, property damages, or environmental impact. Most such events are declared disasters once a certain threshold of impact has been crossed (e.g., more than 100 fatalities, more than $5 million in damages). |
| **disaster proneness** | measure of the **vulnerability** of nations to natural disasters. Some of the most disaster-prone countries are those with high hazard frequencies and low national wealth, meaning that they are not able to respond effectively in the aftermath of a hazard or to mitigate the impact of future hazard events. |
| **driving forces** | societal forces that bring about global environmental change, including population, economic, and technological changes, differing ideologies, and changes in social organizations. |
| **drought** | extended period of unusually dry weather that results in a shortage of water and consequently often a decrease in or failure of food crops. |

**duration** temporal measure of how long the hazard event persists. An **earthquake** may last a few seconds, while a **drought** may continue for several years.

**earthquake** series of vibrations or shocks caused by the sudden motion of plates along a fault. Related hazards caused by earthquakes include **landslides** and **tsunamis**.

**epidemic** far-reaching and commonly rapid outbreak of a disease, affecting hundreds or even thousands of people.

**exposure** the state of being physically at risk from a hazard. Researchers differentiate between voluntary and involuntary exposure to hazards (see **voluntariness**). Examples of involuntary exposure include air pollution (as we must breathe ambient air), toxic contamination of food (as we must eat), and water pollution (as we have to drink). We do, on the other hand, have a greater choice over where we live and what activities we engage in (living in coastal or seismically active zones is to some extent voluntary; smoking or bungee jumping are definitely voluntary).

**famine** state of massive food deprivation leading to malnutrition and death of large numbers of people.

**flash flood** a sudden-onset, severe, but often locally restricted **flood** event occurring mainly in arid or semi-arid areas with steep topography following intense, short-lived rainstorms. Also occur in narrow valleys or developed urban areas where impervious surfaces increase rapid runoff. Warning times are severely limited.

**flood** riverine flooding occurs when a river overflows its banks from heavy rainfall events, snowmelt, ice jams, landslides, or dam failures. Coastal flooding results when water surpasses its tide line. Flood problems can be exacerbated by human activities such as land drainage, river channelization, and deforestation.

**forest fires** the burning of large areas of timber land. Can be caused by lightning, human carelessness, or intentional fire setting. Soil erosion, **landslides**, and **flash floods** can result after the vegetation cover has been burnt.

**frequency** statistical measure for how often a hazard event of a given magnitude and intensity will occur. Often, frequency is measured in terms of a hazard's recurrence interval. For example, a recurrence interval of 100 years for a **flood** suggests that in any year, a flood of that magnitude has a 1% chance of occurring.

**hazard** — the threat to people and the things they value. Environmental events become hazards once they threaten to affect society and/or the environment adversely.

**hazardscape** — the landscape of many hazards. The interaction among nature, society, and technology at a variety of spatial scales creates a mosaic of risks that affect places and the people who live there. The term is normally used in reference to a specific place or region.

**hurricane** — tropical storm with wind speeds of greater than 74 miles per hour. Heavy rains and storm surges above normal tide levels are produced. Hurricanes evolve from tropical depressions and tropical storms. While this type of storm is not unique to the Atlantic Ocean, the term "hurricane" is applied to such storms in that region. For other regionally specific terms see **typhoon** and **cyclone**.

**IDNDR** — International Decade of Natural Disaster Reduction; declared by the United Nations for the 1990's, its goals include improving the capacity of countries to mitigate the effects of natural disasters by improving early warning systems, closing gaps in knowledge in order to reduce loss of life and property, and developing measures for the prevention, prediction, and assessment of natural disasters.

**intensity** — measure of the potential severity of a hazard event and its impacts in human experience. The Mercalli Scale measures intensity based on damage to structures from earthquakes and the perceptibility of the event by humans without instrumentation.

**landslide** — mass movement of unstable earth and rocks down the side of a slope. Can be initiated by long rains or in combination with an **earthquake**.

**magnitude** — measure that describes the strength or force of an event. The Richter Scale measures the magnitude of **earthquakes** through the amount of energy released. Magnitude is an important characteristic for analyzing hazards since only occurrences exceeding some defined level of magnitude are considered extreme, disastrous, or even hazardous.

**megacity** — very large city or giant urban concentration resulting from an existing city that expands to accommodate a growing population (e.g., huge volumes of migrants from rural and other areas) and growing economic base. Megacities are rapidly appearing in the developing world and often involve conurbation (the growing together of formerly separate urban centers while retaining separate urban identities).

| | |
|---|---|
| **Mercalli Scale** | measures the **intensity** of **earthquakes** as experienced by humans and others. Not a measure of the physical forces, but of the impact on humans. |
| **mitigation** | measures or actions that lessen the harmful effects of disasters and hazards. |
| **mudflow** | mixture of soil and water that moves at varying speed down a hillside. The source of the water can be from rainfall or snowmelt. When volcanic ash deposits mix with water, the mudflow is called a lahar. |
| **natural hazard** | hazard event arising from geophysical processes or biological agents -- such as those creating earthquakes, hurricanes, or locust infestations -- that affect the lives, livelihood, and property of people. |
| **pollution** | the release of materials or energy (solid, fluid, or gaseous substances; heat; noise) that are harmful to humans and/or the environment. |
| **preparedness** | the degree of alertness and readiness of an individual or a community immediately before the onset of a hazard event. To enhance preparedness, people plan how to respond in case a disaster occurs and work to increase the resources available to respond effectively. Preparedness activities are designed to help save lives and minimize damage by preparing people to respond appropriately. |
| **prevention** | within technological hazard management systems, this is a type of hazard modification that aims at averting hazards before they even occur. Not using a product with potentially hazardous effects would be one way to prevent a hazard. |
| **rate of onset** | the length of time between the first appearance of the hazard event and its peak. Tornadoes are examples of rapid onset events; soil erosion is much slower in onset. Also called speed of onset. |
| **recovery** | the process of returning to "normality" *after* an emergency occurred. The post-disaster phase that is also used to increase safety and **preparedness** (also see **mitigation**). |
| **resilience** | the ability to recover from the impacts of a hazard event. |
| **resource degradation** | the processes of using up, diminishing, devaluing, or destroying environmental assets that humans use, value, or enjoy resulting in a loss or decreased value of that resource. |

| | |
|---|---|
| **response** | the sum of all actions taken to adjust to hazards; more narrowly defined to mean the appropriate actions taken *during* an emergency to protect people and the things they value from harm, rescue them, and facilitate the transition to post-disaster recovery. |
| **Richter Scale** | a logarithmic scale expressing the amount of energy released in an **earthquake**. |
| **risk** | the likelihood or probability of a hazard event of a certain magnitude occurring. Risks are measures of the threat of hazards. (Note: Definitions of risk in the hazards literature vary from those that equate risk with probability to those that see risk as the product of a probability and a particular kind of impact occurring.) |
| **Saffir-Simpson Hurricane Scale** | measure of hurricane intensity and magnitude by scaling the storm based on central pressure, windspeed, storm surge, and potential damage. Ranges from 1 (minimal) to 5 (catastrophic). |
| **secondary hazards** | hazards resulting from other hazard events. **Landslides** may occur, for example, if the shaking from an **earthquake** causes a mass of rocks and earth to shift beyond its angle of repose. |
| **spatial dispersion** | refers to the pattern of distribution of a hazard over the geographic area in which the hazard can occur. |
| **technological hazard** | human-constructed hazards arising from the interaction of social, environmental, and technological systems. Nuclear technology, pollution, and warfare are examples. |
| **temporal spacing** | refers to the sequencing and seasonality of events. Some events are quite random (volcanoes) while others have seasons (hurricanes). |
| **thunderstorms** | storms characterized by heavy rain and/or hail, strong winds, lightning, and in some instances even tornadoes. |
| **tornado** | extremely violent, localized storm with a characteristic funnel produced by extreme low pressure, enormous wind speeds, and debris circulating around it. Wind velocities can reach 200 miles per hour. They form as funnel clouds from thunderstorms and hurricanes. |
| **tsunami** | giant sea waves generated by seismic action. As tsunamis reach the coast, they can create vast coastal and inland flooding, and often claim many lives. |

**typhoon** tropical storm with origins in the Pacific Ocean. See **hurricane**.

**USDNDR** United States Decade for Natural Disaster Reduction. The national counterpart and outreach from the **IDNDR** with the goal to go beyond current disaster relief efforts to include the reduction of the consequences of hazards through early **mitigation** strategies.

**volcanic eruption** the eruption of molten material, rocks, steam, and other gases from the interior of the earth. Eruption may be continuous and slow (as in Hawaii) or extremely violent (e.g., Mt. St. Helens in Washington). *Nuee ardente*, a hot, poisonous cloud of gas and debris that races down the side of a volcano, is extremely dangerous and lethal.

**voluntariness** the degree to which individuals have a choice over their exposure to a hazard. See **exposure**.

**vulnerability** the potential (susceptibility) for loss or the capacity to suffer harm. While there is an ongoing debate over the appropriate usage and definition of the term, the idea of vulnerability can be applied to individuals, societies, or the environment.

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# Supporting Materials

The materials in this section support the background information and the student activities. Each *Supporting Material* is numbered according to the section or activity in which it may be used. For example, *Supporting Material 1.1* accompanies *Activity 1.1*.

# My Very Own Disaster: A Snow Storm in Texas

*January 28*

*Dear Mom and Dad.*

*As you know, since moving here to Central Texas last summer from Ontario I've experienced quite a few strange things: drive thru beer stores, unintelligible accents mesquite smoked Bar-B-Que and temperatures so high I thought I was going to melt. But today's events are...well unbelievable!*

*You see, the state completely shut down the University because of a threat of freezing rain! Last night's forecast called for "possible freezing rain and snow" so as a safety measure all state offices from Austin to San Antonio have been closed. Can you believe that! Of course, I didn't know any of this until after I walked to school this morning.*

*At school, a friend explained that Central Texas is not at all prepared for the occasional winter storm. The Department of Transportation, for instance, has no salting trucks or plows. The only preventative measures they employ is to throw sand onto bridges and overpasses form dump trucks and to tell people to stay off the roads. It's actually been scary to listen to the radio and watch TV. You'd think it was a major natural disaster. And you know the irony of it all? There's no ice anywhere! Yes, the temperature is hovering around 28 degrees but the streets are clear and empty.*

*Earlier this afternoon, I decided that since I had the day off I might as well see a matinee. I arrived at the theater only to find it closed "due to inclement weather." On my way home I stopped at the grocery store. What a mistake -- the place was packed with people buying batteries and canned goods. The soup aisle was barren.*

*I suppose people here are just reacting normally but it seems strange to me.*

*Yours...snowed in,*

*Michal*



(Source: Lash, Jeff. 1996. Fictitious letter about a not-so-fictitious event in totally real Texas.)

# Hazards and Risks

**Topics available at the WWW *Virtual Library*, http://life.csu.edu.au/hazards/library.html**

## Civil Disturbances
- acts of war
- riots
- urban terrorism

## Epidemics

## Fires
- bush fires
- forest fires
- grass fires
- urban fires
- wild fires

## Geologic Events
- earthquakes
- mass earth movements
- mudflows
- tsunamis
- volcanoes

## Infestations
- insect infestations
- other animal infestations
- plant infestations

## Technological Hazards
- chemical spills
- dust explosions
- gas explosions, leaks
- oil spills
- radiological/nuclear accidents

## Meteorological, Hydrological Hazards
- climate extremes
- droughts
- floods (coastal)
- floods (riverine)
- hailstorms
- hurricanes
- severe storms
- tropical storms

## Emergency Management
- disaster mitigation
- disaster planning
- disaster prevention
- disaster recovery
- disaster response

## Impacts of Disasters
- agricultural production
- cultural heritage
- economic conditions
- human life
- settlements
- social fabric

## Various positions of insurance companies on the issue of climate change

"There is a significant body of scientific evidence indicating that last year's [1990] record insurance losses from natural catastrophes was not a random occurrence. Instead it may be the result of climatic changes that will enormously expand the liability of the property-casualty industry."
(Swiss Reinsurance representative cited from Leggett 1993, in Gordes 1996: 5. ©1996 reprinted by permission of Environmental Energy Solutions. Joel Gordes.)

"Somebody had got off the fence ... they said, if you're asking us, yes, there is a direct link, and this could have an affect on your business. ... We started to incorporate the statements that we had received and the areas we had been warned about, into our whole rating base, which we are glad to say resulted in us reducing our commitments in areas like Florida."
(Anon. syndicate of Lloyd's of London cited from Leggett 1993 in Gordes 1996: 5.©1996 reprinted by permission of Environmental Energy Solutions. Joel Gordes.)

"[C]limate experts that Lloyd's hired could not tell the insurer that global warming was to blame for the unusual severity of recent catastrophic storms, droughts and floods. They [said], 'We can't prove there is global warming. But by the time we can, you chaps will be in real trouble'."
(Richard Keeling in *The Hartford Courant*, 30 March 1995, cited in Gordes 1996: 7. ©1996 reprinted by permission of Environmental Energy Solutions. Joel Gordes.)

The [US insurance] industry mindset is: Is this part of a normal cycle? Or... is it something that society is bringing onto itself and will get worse? This is the fence companies are sitting on. I feel that fossil fuels may be the cause, but I'm afraid of throwing a whole lot of resources at it and finding out it's something completely different."
(Wallace Hanson, Property Loss Research Bureau, cited in Gordes 1996: 11. ©1996 reprinted by permission of Environmental Energy Solutions. Joel Gordes.)

"Higher sums insured, the increasing insurance degree, changed insurance conditions and regulatory practice -- these determinants alone will lead to rising loss burdens for the insurance industry, even if the number of natural catastrophes and major man-made [sic] losses should not change substantially."
(North American Reinsurance Corp 1993: 23. Swiss Re, *Sigma* No. 2/1993: Natural catastrophes and major losses in 1992 - Insured damage reaches new record level.)

## Comments by scientists

"[P]ublic discussions have been shaped in part by the voices of skeptics who argue that because we cannot fully predict the timing or magnitude of climate change, policy responses should be delayed. To insurance executives, however, this is a strange argument, since all of their business -- indeed, its very nature -- involves making important decisions in the face of large uncertainties. ... To an insurance executive, the very uncertainties associated with climate change may be the best reason for taking it seriously." (C. Flavin 1994: 12-13. © 1994 reprinted by permission of Worldwatch Institute. Christopher Flavin.)

**Major Windstorms[1] Worldwide: Annual Impact 1960-1992**

| | 1960s | 1970s | 1980s | 1990s[2] |
|---|---|---|---|---|
| No. of storms | 0.8 | 1.3 | 2.9 | 5.0 |
| Total damage[3] | 2.0 | 2.9 | 3.4 | 20.2 |
| Insured cost[3] | 0.5 | 0.8 | 1.7 | 11.3 |

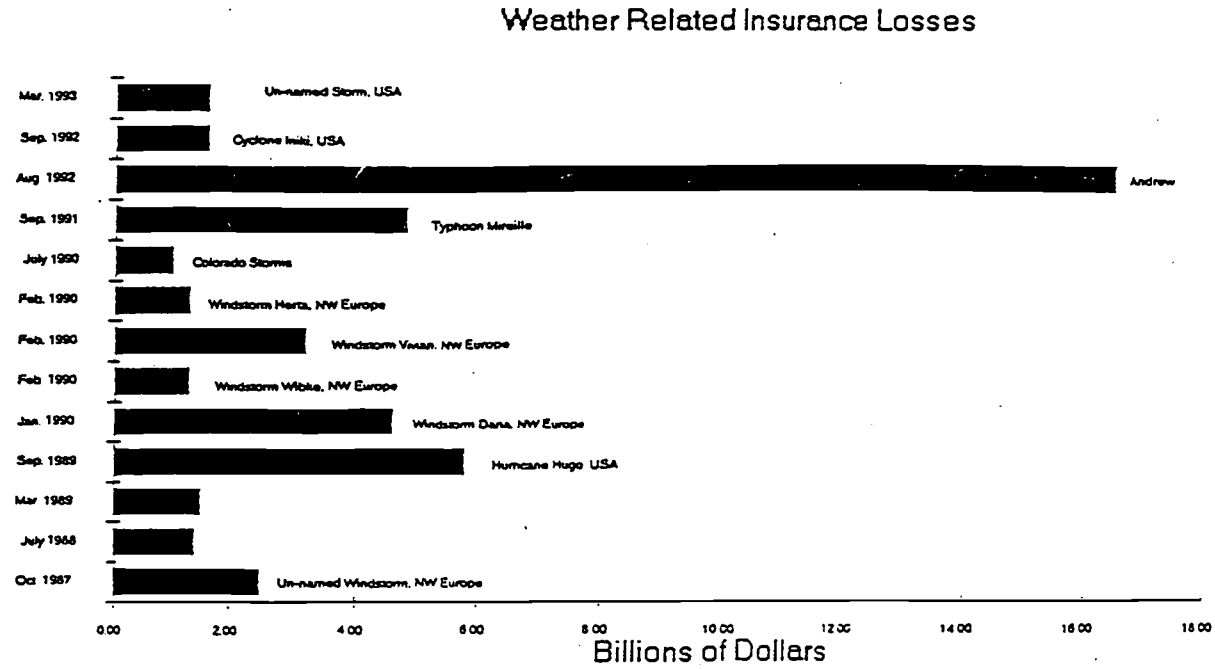
[1] -- a major windstorm is defined as one costing more than $500 M in total damage

[2] -- include only 1990, 1991, and 1992

[3] -- valued in 1990 prices, in billion dollars; data from Munich Re and Swiss Re

(Source: Data extracted from A. Dlugolecki in IPCC 1996: 547, Table 17-1.)

"If the huge ($1.5 trillion per year) fossil fuel industry is the only industrial lobby that actively engages in the climate battle, it is likely to prevail and progress in addressing the global climate dilemma will continue to stall. Few industries are capable of doing battle with the likes of the fossil fuel lobby. But the insurance industry is. On a worldwide basis, the two are of roughly comparable size -- and potential political clout."
(C. Flavin 1994: 20. ©1994 reprinted by permission of Worldwatch Institute. Christopher Flavin.)



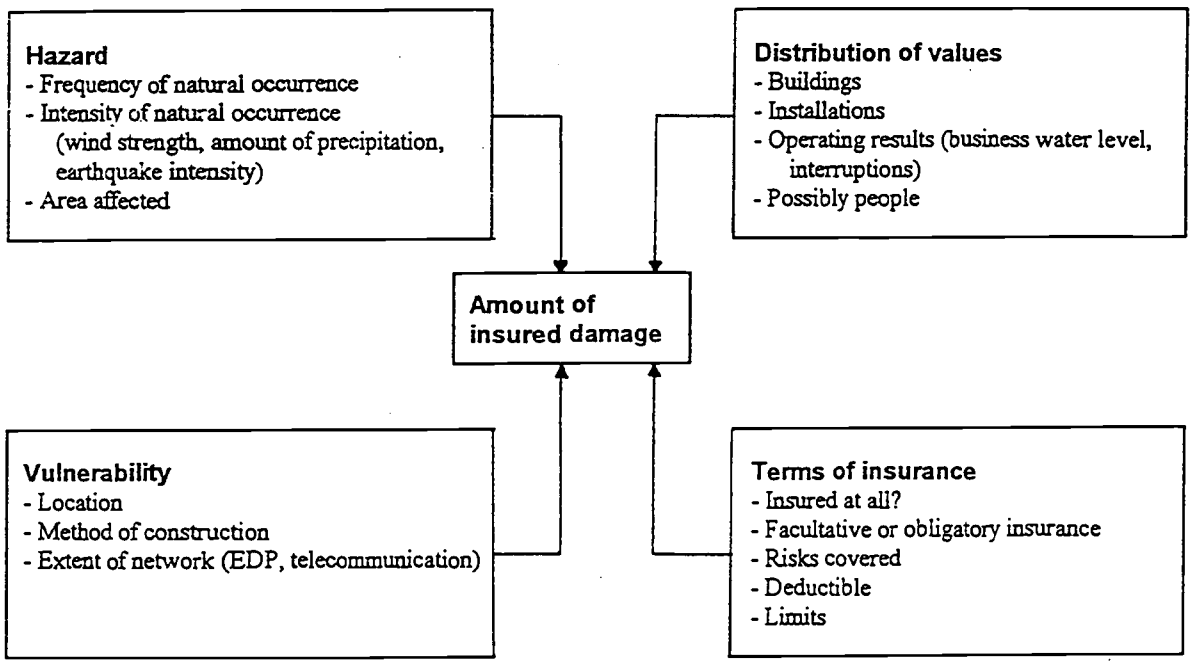

Source: J. Gordes. ©1996 reprinted by permission of Environmental Energy Solutions. Joel Gordes.

## Newspaper excerpts

"[Commerce Insurance Co.] spokesman Tony Batista said Commerce is ceasing to write homeowner policies on Cape Cod, the Islands, and [locations] within two miles of the Massachusetts coast north of Plymouth because it cannot find suitable reinsurance to protect itself from potential losses from hurricanes and other storms."
(Coakley, T. 1993, p 1. ©Reprinted courtesy of *The Boston Globe*: "Insurers wreck calm before next storm," by Tom Coakley.)

"Maxine Texeira lives a good 10-minute walk from the nearest beach -- on protected Boston Harbor. She has made it through hurricanes and Northeasters in the past 23 years with no insurance claims for storm damage. So why, she asks..., has her insurance company included her among 18,000 [Massachusetts] residents whose homeowner coverage will not be renewed because of her home's 'susceptibility to catastrophic coastal storms.'... Maxine Texeira isn't sure what she will do. And she still can't figure out why her policy isn't being renewed. "I don't live on the coast," she said. "I live in East Boston."
(Coakley, T. 1993: 1,15. ©Reprinted courtesy of *The Boston Globe*: "Insurers wreck calm before next storm," by Tom Coakley.)

## Determinants of Insured Damage




Source: North American Reinsurance Corporation, 1993, their Figure 5. Swiss Re, *Sigma* No.2/1993: Natural catastrophes and major losses in 1992 -- Insured damage reaches new record level.

**INSURERS CALL FOR CUTS IN GREENHOUSE GAS EMISSIONS --** Adapted excerpts from a press release during the Second Conference of Parties in Geneva, July 9, 1996

Insurance executives speaking on behalf of almost 60 insurance companies addressed delegates of the climate change negotiations in Geneva by calling for early and substantial reductions in greenhouse gases. The executives presented a position paper highlighting the industry's concern that, while the effect of climate change on the frequency or severity of extreme weather events remains unknown, it is clear that even small shifts in regional climate zones or storm patterns could lead to increased property damage. The insurers also pointed out that climate change could potentially have large implications for investment activities as society anticipates and adapts to the new climate regime.

"While some industries think more about the costs of taking action against climate change, insurers know from experience how expensive it can be when people fail to protect themselves adequately from risks," UNEP Executive Director Elizabeth Dowdeswell said.

Because property insurance is particularly vulnerable to direct climatic influence, a higher risk of extreme events due to climate change could lead to higher insurance premiums or the restriction of coverage for property in some vulnerable areas. However, as it is still not possible to quantify any present or future changes in the risk of extreme events, insurance companies find it difficult to adjust their products and capital reserves appropriately. The withdrawal of insurance would increase direct financial loses to property owners and businesses, with serious long-term implications for communities and governments. In addition, if unexpectedly severe events started causing insurance companies to become insolvent, other economic sectors such as banking and public finances could feel the ripple effects.

Several large industrial associations have taken an aggressive stance against climate change, emphasizing the existence of scientific uncertainty, the high cost of changing technologies, and the possible benefits for some regions. Faced with this situation, and the growing importance of such global issues to their activities, a number of insurers decided in November 1995 to combine under the aegis of the UN Environmental Programme to constitute the UNEP Insurance Industry Initiative on Sustainable Development and the Environment. This gives the insurance industry its own voice on climate change and can offer policy-makers better information on appropriate solutions to cope with the financial challenges of climate change.

# Scenarios for the Simulation Game of Mitigation Strategies

## Scenario 1

### Metropolis -- USA

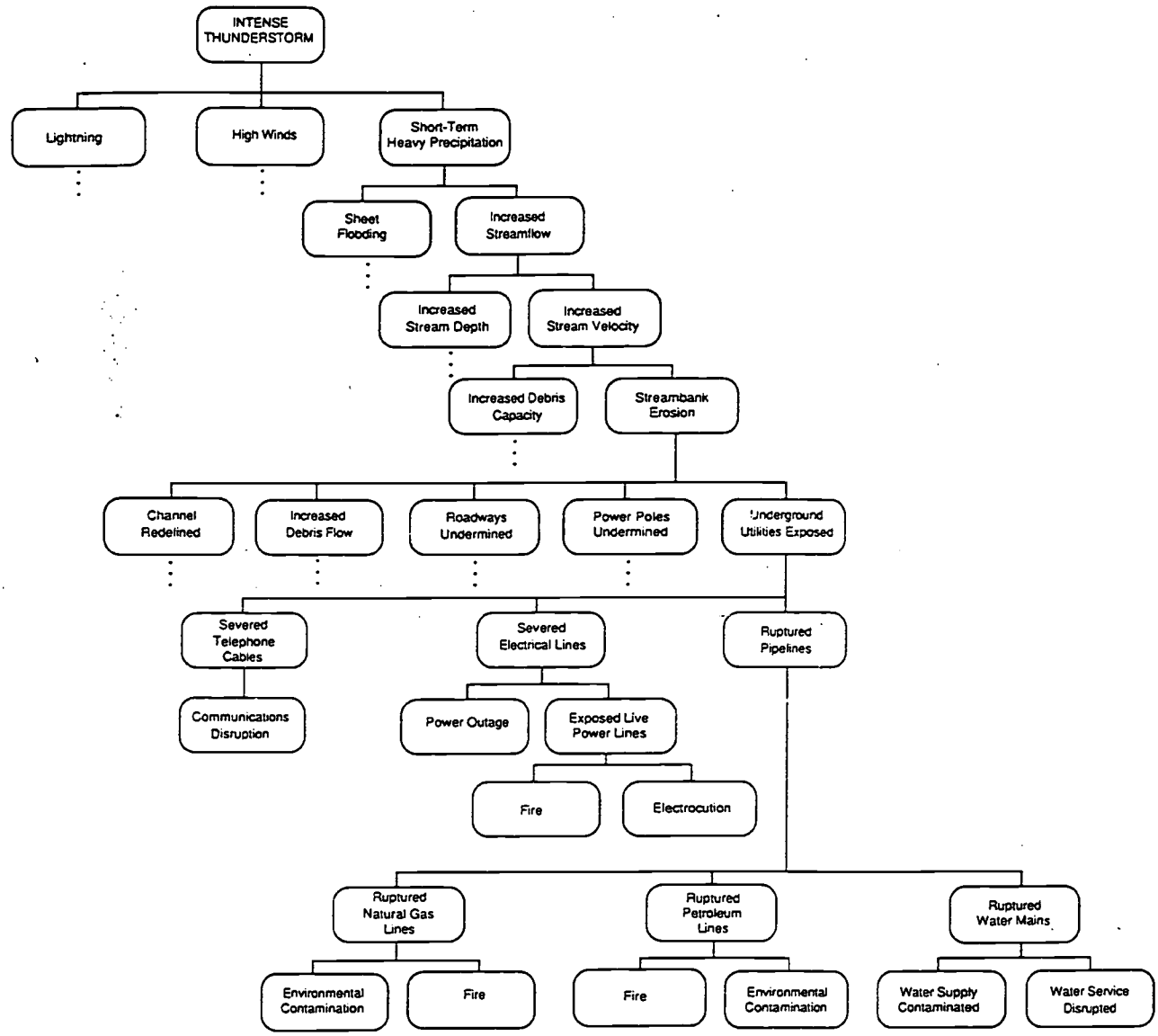
The city of Metropolis is home to 50,000 people and is a thriving ocean port. Most electric power is supplied by the Metropolis Energy Company's Four Mile River Nuclear Plant. Telephone communications are of the best quality. Four television stations and ten radio stations serve the greater metro area. The Four Mile River has been dammed near its source in the Northern Mountains to create a reservoir. Rumors about poor dam construction have died down since it was built forty years ago. The Metropolis River runs south from the mountains as well, but takes its course through residential neighborhoods and runs adjacent to the downtown central business district. Two major interstate highways, one running parallel to the R&R Railroad, service the city and connect the port to points inland. Heavy industry is located throughout the city, including three chemical manufacturing plants each of which has its own trucking line. The arrival of new industry has displaced some poorer people who were living near downtown. Some centrally located neighborhoods are inhabited by the poor. The topography surrounding the city extends from level sea plains on the coast to undulating foothills resting at the base of the Northern Mountains. Cutting in a southwest direction from the mountains is a well-defined valley, known by the geologists at Metropolis University as the Mercalli Fault. Metropolis is governed by a city council of seven and served by a mayor as well. Among the mayor's cabinet officers is the Emergency Planner. The city maintains its own police and fire departments. There are also several community-based groups with multiple agendas, such as conservation and anti-pollution, for the benefit of Metropolis. The economy has been good and the people find themselves happy with their lives, quite complacent and almost routine, until today....

## Scenario 2

### Puerto Grande -- Ecuador

The city of Puerto Grande is home to 50,000 people and is an ocean port. Most residents do not have electric power, but a new government program has begun testing a nuclear power facility near the Four Mile River. Communications are fair in the downtown area, but most residents do not have ready access to telephones. There is one state-owned television station and two radio stations. The Four Mile River was dammed forty years ago in a modernization phase to provide electricity. The dam has since fallen into disrepair and rumors of poor management abound. The Puerto Grande River also runs south from the Northern Mountains, but takes its course through wealthy neighborhoods and runs adjacent to a small, but growing central business district downtown. There is one two-lane highway leaving the port area for points inland. Most roads are paved for short sections and remain unpaved throughout vast portions of the city. The rush to modernize has seen several foreign-owned companies, including three major chemical plants, set up shop around the outskirts of downtown. To spur development, taxes were waived and the industries remain unregulated. The topography surrounding the city extends from level sea plains on the coast to undulating foothills resting at the base of the Northern Mountains. Cutting in a southwest direction from the mountains is a well-defined valley. Older residents recall that earthquake activity transpired in the valley during their youth. As the city has grown in population, land pressures have forced poorer residents toward less desirable land in the foothills and toward the Northern Mountains. Some have also found refuge on some open land near one of the chemical plants, hoping to find better employment as well. There are several islands off the near coast that are used for farming and fishing by small families, as they have done for generations. Puerto Grande is governed by a mayor and city council of seven. Although all were elected to their positions, most residents believe that they were hand picked by the state political machine. There is no Office of Emergency Planning. The police department is understaffed and the fire department filled largely with volunteers. The economy has been weak in recent years, and the people are not optimistic about future economic gains. Their existence is marginal, routine from day to day, until now....

# The hazard that triggered a hazard that triggered a hazard....




Source: National Research Council. 1991. *A safer future: Reducing the impacts of natural disasters.* Washington, DC: National Academy Press, p. 15. Reprinted with permission from A SAFER FUTURE: REDUCING THE IMPACTS OF NATURAL DISASTERS. ©National Academy of Sciences. Courtesy of the National Academy Press, Washington, DC.

# English and American Nature Writers

## (an incomplete listing in somewhat chronological order...)

**Gilbert White** 1720-1793
father of nature writing? English naturalist, *The Natural History and Antiquities of Selborne*

**John James Audubon** 1785-1851
birds, Ornithological Biography (5 vols.)

**Charles Waterton** 1782-1865
English naturalist and explorer, *Wanderings in South America*

**Ralph Waldo Emerson** 1808-1882
father of American nature writing? US East Coast, *Nature, Journals*

**Henry David Thoreau** 1817-1862
teacher, botanist, philosopher, New England, *Walden, The Maine Woods, Journals*

**Walt Whitman** 1819-1892
American poet, *Specimen Days, Leaves of Grass*

**John Wesley Powell** 1834-1902
explorer, Colorado River, Grand Canyon, *Explorations of the Colorado River of the West and its Tributaries*

**Charles Darwin**
English naturalist, South America, *Voyage of the H.M.S. Beagle, Origin of Species*

**Herman Melville** 1819-1891
*Moby Dick*

**Alfred Russel Wallace** 1823-1913
naturalist, South America, *Travels on the Amazon and Rio Negro, The Malay Archipelago*

**Joseph Ward Krutch** 1893-1970
NY drama critic and professor of literature, urban, *The Modern Temper: A Study and a Confession, Love in the Desert*

**Isak Dinesen** 1883-1962
Danish writer, colonial Kenya, *Out of Africa*

**John Muir** 1838-1914
explorer, environmental activist, Wisconsin, *Yosemite, A Wind Storm in the Forests, Gentle Wilderness, Mountains of California*

**Aldo Leopold** 1888-1948
professional conservationist, land ethics, Wisconsin, *A Sand County Almanac*

**Rene Dubos** 1901-1982
microbiologist, environmentalist, *The Wooing of Earth*

**Rachel Carson** 1907-1964
marine biologist, environmentalist, *The Sea Around Us, The Edge of the Sea, Silent Spring*

**Loren Eiseley** 1907-1977
*The Judgment of Birds, The Star Thrower*

**Wallace Stegner** b. 1909
novelist, short story writer, inter-mountain American west, *The Sound of Mountain Water*

**Edward Abbey** 1927-1989
park ranger, environmentalist, American Southwest, *Desert Solitaire, The Monkey Wrench Gang*

**Peter Matthiessen** b. 1927
global explorer, writer, *At Play in the Fields of the Lord, The Tree Man was Born, The Wind Birds, The Snow Leopard*

**John McPhee** b. 1931
essayist, US focus, *Coming Into the Country, The Pine Barrens, Encounters with the Archdruid, The Control of Nature*

**Wendell Berry** b. 1934
essayist, poet, agriculture and farming, Kentucky, *The Unsettling of America, The Men of Old Jack, Farming: A Handbook, Clearing*

**N. Scott Momaday** b.1934
Kiowa heritage, *The Way to Rain Mountain, House Made of Dawn, The Gourd Dancer*

**Annie Dillard** b.1945
writer on "what it feels like to be alive," *Blue Ridge Mountains, Pilgrim at Tinker Creek, Teaching a Stone to Talk*

**Rick Bass** b. 1958
contemporary, petroleum geologist turned writer, Texas, Montana, *Oil Notes, Deer Pasture, Winter, Ninemile Wolves*

**Norman Maclean** b.1902
English professor, fishing, Idaho, Montana, *A River Runs Through It and Other Stories*

**John Hay** b.1915
writer, outer environment and inner lives, *The Run, In Defense of Nature*

**John Graves** b.1920
Texas writer, *Good-bye to a River, Notes from a Limestone Ledge, Hard Scrabble*

**Leslie Mormon Silko** b.1948
writer, poet, ritual and myth in life, *Ceremony, Laguna Women, Storyteller*

**Robert Finch** b. 1943
essayist, Cape Cod, *The Cape Itself*

**David Ehrenfeld** contemporary
ecologist, *The Arrogance of Humanism*

**Brenda Peterson** b. 1950
essayist, *Nature and other Mothers: Reflection on the Feminism in Everyday Life, Living by Water: Essays on Life, Land and Spirit*

**John R. Stilgoe** b. 1949
history of landscape, *Metropolitan Corridor: Railroads and the American Scene*

**J Ronald Engel** contemporary
professor of social ethics, *Ethics of Environment and Development, Sacred Sands*

**Barry Lopez** b. 1945
essayist, short story writer, US, *Arctic Dreams, Of Wolves and Men, Crossing Open Ground*

**Darrell Addison Posey** b. 1947
ethnobiologist, Kayapo Indians of Brazil, The Science of Mebengkre
**John Elder** b. 1947
English professor, *Imagining the Earth: Poetry and the Vision of Nature*
**Susan Power Bratton** b. 1951
ecologist, parks and wilderness protection, *Christianity, Wilderness and Wildlife*
**David Abram** b. 1957
ecologist, magician, essays appear in *The Ecologist* and *Environmental Ethics*
**Terry Tempest Williams** b. 1955
naturalist, Utah, *Pieces of White Shell: A Journey to Navajoland, Coyote's Canyon*
**Scott Russell Sanders** b. 1945
English professor, *Secrets of the Universe: Scenes from the Journey Home, The Paradise of Bombs*
**Starhawk** contemporary
writer, ecofeminist, spirituality, witch by self-description, *The Fifth Sacred Thing, Walking to Mercury*
**Gary Nabhan** b. 1952
ethnobiologist, American Southwest, Papago Indians, *The Desert Smells Like Rain*
**Ann Zwinger** b. 1925
art and art history, Colorado Rockies, American West, Baja peninsula, *Beyond the Aspen Grove, Mysterious Lands*
**Jim Nollman** contemporary
interspecies communication, *Dolphin Dreamtime, Spiritual Ecology, Animal Dreaming*
**Charles Bergman** contemporary
English professor, absence or loss of nature, *Wild Echos: Encounters with the Most Endangered Animals in North America*

# Finding Home: The Role of Nature Writing*

In his introduction to *Finding Home*, Peter Sauer asserts that "nature -- the way we understand the natural world -- is changing, and this transformation carries with it all the makings of a cultural revolution . . . A society's conceptual relationship to nature," he continues, "is at the core of its culture: it is a relationship that underlies what we believe and how we live." Evidence of such a relationship may be found in English Language nature writing over the last two hundred years. Perhaps all nature writers are children of Linnaeus, who in the mid-eighteenth century, introduced a framework within which all living things could be classified and identified. Parsons, poets, ladies and gentleman of leisure in England, explorers and collectors in the wilds of America, all carried their copies of Linnaeus.

In America, the early prominence of nature writing is associated with the exploration of an abundant continent. Naturalists were commissioned, first by amateurs and institutions in Britain and then by the fledgling American government, to travel, draw maps, keep lists, and ship specimens. Both the cultural climate and the natural environment fostered a genre of nature writing in English. In this genre, the personal element -- the filtering of experience through the individual's sensibility -- is central to the nature writing tradition. Nature writers take excursions away from dominant literary and scientific models, returning with their testimony about how human beings respond to what is non-human and how individuals and societies may achieve more significant and rewarding integration with the earth that sustains them. Often the accounts convey a proprietary tone that colors nature writers' descriptions of their chosen or ultimate landscapes -- from Henry David Thoreau's Concord to John Muir's Sierra to Edward Abbey's Arches National Monument.

Today, nature writing in America is flourishing. John Elder and Robert Finch, both nature writers in their own right, assert in the introduction to *The Norton Book of Nature Writing*, that "nonfiction may well be the most vital form of current American literature, and a notable proportion of the best writers of nonfiction practice nature writing." Nature writing has attracted poets such as John Hay and Wendell Berry and novelists and essayists like Peter Mathhiessen, Annie Dillard, John McPhee, Barry Lopez, and Leslie Mormon Silko. In addition, writers like Rachel Carson, Loren Eiseley, and Ann Zwinger have, in their literary essays, imbued their respective fields of marine biology, anthropology, and art with humanistic concerns.

All these writers contribute to the way we, as a culture, understand the natural world. How we understand the world around us, influences how we will respond to changes within it. At a time when there is growing consensus that nature is changing and that the natural world has been fundamentally altered by humankind, nature writing might provide invaluable insight into the human impacts of and responses to environmental change. Such insights might lead to a better understanding of our behavior toward the environment and might allow for a more perfect union with nature.

* Adapted from: Peter Sauer, ed. 1992. *Finding home.* Boston: Beacon Press; and Robert Finch and John Elder, eds. 1990. *The Norton book of nature writing.* New York: W.W. Norton and Company.

# Locus of Control

Read the following statements and find the one(s) that best capture your own beliefs.

❑ Because a handful of key individuals really affect the decisions of a politician on an environmental issue, people like myself are relatively ineffective in determining the outcome of environmental quality.

❑ Since politicians probably form their own ideas about solutions to environmental problems, it would be useless to contact and present them with my views on the issues.

❑ Achieving and maintaining environmental quality is really the result of chance happenings since any conservation practices I could utilize would be ineffective or simply not sufficient.

❑ Outcomes of environmental issues are unpredictable, so my use of ecologically sound practices seems pointless.

❑ If I were to report the violation of an environmental law, it would either be luck or coincidence if anything came of it, i.e., if the violation really came to a halt.

❑ I support environmental and social lobbies hoping that it'll make some kind of difference, but I don't really believe it will make any major difference.

❑ If I don't act on behalf of the environment, who will?

❑ Even if I don't make a huge positive difference, at least I don't collaborate with those who act to destroy the environment. I don't want to have any part in that, if I can avoid it.

❑ Of course, I can affect environmental quality. There are so many ways in which I do: I call and write to my congress person, I behave in ecologically responsible ways, I think about what kinds of products I buy and thus what kind of economy I support, I support environmental and human rights groups, and I can try to convince others to do the same.

Source: Adapted and extended from N.J. Smith-Sebasto. 1992. The revised perceived environmental control measure: A review and analysis. *Journal of Environmental Education* 23, 2: 24-33; statements derived from his on p.27.

# Appendices

## Appendix A: Selected Internet/WWW Hazards Sites

This annotated list of World Wide Web resources describes sites that are dedicated to some aspect of hazards research. Some are intended for hazard management professionals; others are geared towards researchers, and some toward the general public. Most of the sites listed here provide links to related sites. This bibliography was compiled during July of 1996. Some sites improve over time, others vanish, so it is advisable to check these sites out before using them in the classroom. Highly recommended sites are marked with **.

### Hazards -- General

****WWW Virtual Library -- Hazards**
**http://life.csu.edu.au/hazards/library.html**

The WWW Virtual Library provides a vast number of links to all sorts of hazard-related sites. This is an excellent place to begin hazard research.

**University of Wisconsin -- Madison Disaster Management Center**
**http://epdwww.engr.wisc.edu/dmc/**

This site provides information about a number of self-study courses in disaster mitigation and management.

**Disaster Management and Mitigation Group -- Oak Ridge**
**http://stargate.ornl.gov/StarGate/DMMG/dmmg.html**

The DMMG group conducts research on disaster management and mitigation strategies. They offer a series of courses for emergency management professionals. The site provides links to other related areas of interest.

**Disaster Research Center -- University of Delaware**
**http://www.udel.edu/nikidee/drc.htm**

The center provides a large list of available publications, most designed for hazard professionals, as well as general information about hazard research.

**International Decade for Natural Disaster Reduction**
**http://hoshi.cic.sfu.ca/~hazard/idndr.html**

This site is still under development, but when complete will include global hazard maps, international information about hazard mitigation and research, and links to other hazard-related sites.

****Natural Hazards Center at the University of Colorado -- Boulder**
**http://adder.colorado.edu/hazctr/Home.html**

The center is a clearinghouse for hazard information for both the United States and the world. The site has issues of the center's newsletter, a number of publications, and a large number of links to related sites.

**Federal Emergency Management Agency**
**http://www.fema.gov/**

This site has been rated as one of the top 5% on the Internet. There is extensive information about the role of FEMA, about disaster management and mitigation, and recent and current FEMA efforts.

**Hazards Research Lab -- University of South Carolina**
**http://www.cla.sc.edu/geog/hrl**

The hazards lab at the University of South Carolina is dedicated to using geographic information processing techniques for the study and analysis of hazards. The site provides information about the center as well as links to other hazard-related sites.

**Universities Water Information Network**
**http://www.uwin.siu.edu**

If you are looking at water-related hazards, try this site and search for the topic or location that interests you via the site's search option.

**International Journal of Mass Emergencies and Disasters**
**http://www.ias.unt.edu:9510/mead/mead.html**

This site is still mostly under construction at the time of writing. It's the online version of this well- known journal.

**Natural Disaster Reference Database**
**http://ttpwww.gsfc.nasa.gov/ndrd-cgi/ndrd**

Speed up your bibliographic searches on any natural disaster at this site. Once you choose a type of disaster from its subject database, you will go on to gopher menus with over 1000 references on the subjects, with abstracts, keywords, and information on how to obtain the paper included.

**Canada Emergency Preparedness Information Exchange**
**http://hoshi.cic.sfu.ca/~anderson/**

Accessible in French and English, this Simon Fraser University site provides linkages to agencies, groups, cities, etc. involved in Canada's emergency preparedness activities. Also notable is the site's access to all kinds of information about the International Decade for Natural Disaster Reduction, and its linkage to SFU's HazardNet homepage, currently still under construction, which is a good starting point to research specific types of hazards.

## Earthquakes and other Geophysical Hazards

****USGS Geological Survey**
**http://www.usgs.gov**

This is the USGS Homepage. Go via USGS by Theme to information on hazards, natural resources, and the environment. Each of these options goes on to hazard and/or global change related topics. For example, Resources leads to Energy, which in turn leads to issues related to the radon hazard and a nice US map of radon potential.

**USGS National Earthquake Information Center**
**http://www.usgs.gov/fact-sheets/neic/title.html**

This site provides a list of the products offered by the National Earthquake Information Center. A good source for ordering classroom materials for physical geography.

**University of Nevada-Reno Seismological Laboratory**
**http://www.seismo.unr.edu/index.html**

Plentiful information about earthquakes including hazard maps for much of the United States. There is also a large amount of general information about everything from plate tectonics to earthquake building codes.

**National Geophysical Data Center
**http://www.ngdc.noaa.gov/ngdc.html**

This site provides an excellent starting point for research. There are extensive links to all sub-fields of earth science and a link to hazards research.

**Central U.S. Earthquake Consortium
http://gandalf.ceri.memphis.edu/~cusec/index.html**

The Central U.S. Earthquake Consortium is a group of emergency management organizations from six central U.S. states: Arkansas, Indiana, Illinois, Kentucky, Tennessee, and Missouri. The site contains information about the organization, as well as links to sites maintained by member organizations. It emphasizes disaster preparedness and emergency management.

**Southern California Earthquake Center
http://www.usc.edu/dept/earth/quake/**

The Southern California Earthquake Center is dedicated to earthquake forecasting in Southern California. The site provides a lots of information about the center, and some information about seismic activity in the region, but has few links to other sites.

**Earthquake Engineering Research Center -- Berkeley
http://nisee.ce.berkeley.edu**

The Center is home to some of the world's foremost experts in earthquake hazard mitigation through engineering. The site provides ample information about earthquake engineering. It also contains a data bank of over 5,000 earthquake slides. The slides can be viewed in digital form, or purchased for $2.00 each.

**Seismosurfing
http://www.geophys.washington.edu/seismosurfing.html**

Over 100 links to earthquake related sites are provided here. This is a good place to begin searching for earthquake information.

**USGS Cascades Volcano Observatory
http://vulcan.wr.usgs.gov/IndexList/framework.html#top**

What don't you know about volcanoes yet? Go to this site, search through an alphabetically accessible index, and read up on it. Descriptions and explanations are taken from up-to-date research article, but very readable. Textbook-like.

**National Landslide Information Center**
**http://gldage.cr.usgs.gov/html_files/nlicsun.html**

Landslide information from the general to the specific, event reports, slides, publications, etc.

****Tsunamis**
**http://tsunami.ce.washington.edu/tsunami/counter.acgi?view**

The tsunami site contains lots of information including the physics of tsunamis, a survey of the human impact of the great waves, and links to related sites.

**Science of Tsunami Hazards**
**http://www.ccalmr.ogi.edu/STH**

The International Journal of the Tsunami Society's web site with access to the Table of Contents and abstracts of current and past issues. Also linkages to some two dozen other tsunami sites.

****Global Earthquake Report**
**http://geovax.ed.ac.uk/quakexe/quakes**

This site is a worldwide earthquake locator. It lists all the recent earthquakes and then allows the viewer to see the location of the quake on a map of the appropriate region.

****Volcano World -- University of North Dakota**
**http://volcano.und.nodak.edu/**

This has been rated as one of the top 5% of sites on the Internet. Amazing photographs, plenty of maps, up-to-date information, and lots of related information.

**Electronic Volcano**
**http://www.dartmouth.edu/pages/rox/volcanoes/elecvolc.html**

Another excellent volcano site. Includes an introduction in six different languages. This site contains information both for the amateur and for the professional vulcanologist.

## Health Disasters/Emergencies

**National Institute for Occupational Safety and Health**
**http://www.cdc.gov/diseases/niosh.html**

See Centers for Disease Control.

**Centers for Disease Control**
**http://www.cdc.gov**

This is the homepage for the Centers for Disease Control. It leads to information about disease and epidemics from around the world. From here you have access to the National Institute for Occupational Safety and Health.

**Pan American Health Organization**
**http://www.paho.org/**

This site provides information about health-related issues in the Americas. It provides links to health organizations in most Central and South American countries.

**World Health Organization**
**http://www.who.ch/**

This site contains general information about the W.H.O. which can be found via a searchable interface. There is also up-to-date information about disease outbreaks.

**Red Cross/Red Crescent**
**http://www.ifrc.org**

The disaster relief organization's homepage provides information about relief efforts from around the world. There are also ample links to other disaster-related sites.

**Agency for Toxic Substances and Disease Registry**
**http://atsdr1.atsdr.cdc.gov:8080**

Rated one of the top sites on the Internet, the site features a search engine that helps find specific information regarding toxic chemicals and disease.

**Dutch National Institute of Public Health and Environmental Protection**
**http://deimos.rivm.nl/**

This site is largely under construction still, but will provide valuable information on global change, public health and environmental research undertaken at the RIVM. At present their list of publications indicates the breadth of information available from them.

## Technological Hazards

**Pollution Mapping Projects and Toxic Databases**
**http://www.envirolink.org/issues/pollution-map/index.html**

Toxic pollution maps for a number of world regions, plus information about hazardous waste.

**Hazardous Waste Research and Information Center**
**http://www.inhs.uiuc.edu/hwric/hmlhome.html**

The Center provides a good deal of information about hazardous waste. The site includes information on pollution prevention and pollution clean-up efforts.

## Drought

****National Drought Mitigation Center**
**http://enso.unl.edu/ndmc.**

The National Drought Mitigation Center is dedicated to reducing societal vulnerability to drought. The site contains information about drought climatology, drought mitigation, and up-to-date information on current and emerging droughts. There are also links to related sites.

## Atmospheric/Hydrologic Hazards

**National Lightning Safety Institute**
**http://www.lightningsafety.com**

Information about lightning safety, as well as lightning hazards. The site includes some dramatic images of lightning strikes.

****NOAA**
**http://www.hpcc.gov/blue94/section.4.8.html**

The homepage for NOAA provides information about the agency and links to related sub-agencies. Including the National Climatic Data Center and National Oceanographic Data Center which are also directly accessible at the following addresses.

**National Climatic Data Center**
**http://www.ncdc.noaa.gov/**

**National Oceanographic Data Center**
**http://www.nodc.noaa.gov/**

****National Hurricane Center**
**http://www.nhc.noaa.gov/**

The Hurricane Center's homepage contains images of many recent hurricanes, as well as storm tracks. Other graphics include storm probability, and historic hurricane tracks.

****Tornadoes**
**http://cc.usu.edu/~kforsyth/Tornado.html**

The Tornado homepage provides a good introduction to tornados with basic information, and some recent statistics. The site also provides a number of links to other sites. This is an excellent place to begin research on the subject.

****Global Flood Monitoring and Analysis Project**
**http://www.dartmouth.edu/artsci/geog/floods/Index.html**

This site has satellite images of recent floods, graphics showing global flood damage, and a wealth of other information on the subject.

## Disaster Response

**National Center for Urban Search and Rescue**
**http://niusr.org/~usar**

This site offers information on emergency preparedness, emergency response, and disaster relief -- all US-oriented. Interesting for its *Vision 2000* statement, and linkages to emergency preparedness sites of cities located in hazardous areas (e.g., San Francisco).

## Environmental/Demographic Data, NGOs

**CIESIN World Data**
**http://www.ciesin.org/datasets/dataset-home.html**

This site provides a vast amount of information on the human dimensions of global change. The Consortium for International Earth Science Information Network's mission is to make available existing data to other researchers, decision makers, educators and the public, to establish easy access to data, set up linkages to related data sources, and to attempt integration between socioeconomic and natural scientific data in order to assist in environmental decision making. There are interactive maps, searchable data sets, and an enormous amount of related information for both human and physical geography. Socioeconomic data are available through CIESIN's Socioeconomic Data and Application Center (SEDAC).

**The Environmental Magazine**
**http://www.emagazine.com**

This online environmental magazine, conceived in the "greenhouse summer" of 1988, provides background information to many global change, environmental, human health, and hazard issues, for example an article on Mad Cow disease in its July/August 96 issue. Thus it is relatively up-to-date with hazards in the news at any one point in time.

**Econet**
**http://www.econet.apc.org/econet/**

Econet is intended to provide connections for groups and individuals working on environmental issues. The site provides news from hundreds of conferences and reports.

**EcoWeb**
**http://ecosys.drdr.virginia.edu/EcoWeb.html**

The EcoWeb at the University of Virginia provides a good deal of information about environmental and social issues. It is a jumping board to issues ranging from AIDS to indigenous peoples to the German Greens and peace activist groups.

**Envirolink Network**
**http://www.envirolink.org**

A nicely designed website that is truly what its name promises: a node linking environmental websites. It's organized around the four elements, Air, Fire, Water and Earth, plus an extra category for Flora and Fauna, and is great on pollution and some global change issues.

**Environmental News Network**
**http://www.enn.com:80**

The CNN of the environment! Daily news about all kinds of environmental issues. An easy way to find out what's going on, and to stay tuned in on specific issues.

**Greenpeace International**
**http://www.greenpeace.org/**

Greenpeace's homepage provides access to archival data and to updates on its various national and international campaigns on toxics, nuclear, atmospheric, and biodiversity issues.

**The Nature Conservancy**
**http://www.tnc.org**

This site is The Nature Conservancy's homepage and gives you access to information about its activities. If you do a keyword search for "hazard" it lists any hazard issue TNC is involved in.

**Rainforest Action Network**
**http://www.ran.org**

Most up to date on all rainforest-related issues, activism, networks. Good background information on the environmental and socio-economic situation in tropical countries.

## Appendix B: Selected Readings on Disasters and Mitigation

The following is a selection of critical perspectives on human-influenced or -induced disasters (like war and famine), international disaster relief efforts, and the linkages among environmental degradation, human rights violations, and disasters.


Bread for the World Institute. 1990. *Hunger 1990*. Washington, DC: BWI.

Broad, Robin and John Cavanagh. 1993. *Plundering paradise: The struggle for the environment in the Phillippines*. Berkeley, CA: University of California Press.

Cahill, Kevin M. 1993. *A framework for survival: Health, human rights, and humanitarian assistance in conflicts and disasters*. New York: Basic Books.

Cohen, L.J. 1993. *Broken bonds: The disintegration of Yugoslavia.* Boulder, CO: Westview.

Cornia, Giovanni Andrea, Richard Jolly, and Frances Stewart (eds.). 1988. *Adjustment with a human face, Vol 2.* Oxford. UK: Claredon Press.

DeWaal, Alex. 1989. *Famine that kills*. Oxford, UK: Clarendon Press.

Doornbos, Martin *et. al.* (Eds.) 1992. *Beyond conflict in the Horn.* Trenton: Red Sea Press.

Harrel-Bond, B.E. 1986. *Imposing aid: Emergency assistance to refuges.* London: Oxford UP.

Human Rights Watch and Natural Resources Defense Council. 1992. *Defending the earth: Abuses of human rights and the environment.* Washington, DC: HRW, NRDC.

Maskrey, Andrew. 1989. *Disaster mitigation: A community based approach*. Development Guidelines No. 3. Oxford, UK: Oxfam.

National Research Council. 1991. *A safer future: Reducing the impacts of natural disasters.* Washington, DC: National Academy Press.

Radcliff, Sarah A. and Sallie Westwood (eds.). 1993. *Viva: Women and popular protest in Latin America.* New York, London: Routledge.

Rau, Bill. 1991. *From feast to famine.* London: Zed Books.

Richards, Paul. 1985. *Indigenous agricultural revolution*. Hutchinson.

United States Department of State. 1993. *Hidden killers: Global problem with uncleared landmines.* Washington, DC: Government Printing Office

# Appendix C: Suggested Readings

The AAG was able to obtain reprint permission from the original publishers for only some of the readings suggested in the activities of this module. To avoid copyright problems, we suggest you make these readings available to your students by putting them on reserve. The following readings are enclosed:

- Flavin, Christopher. 1994. Storm warnings: Climate change hits the insurance industry. *World Watch* 7, 6 (November/December): 10-20. ©1994 reprinted by permission of Worldwatch Institute. Christopher Flavin.

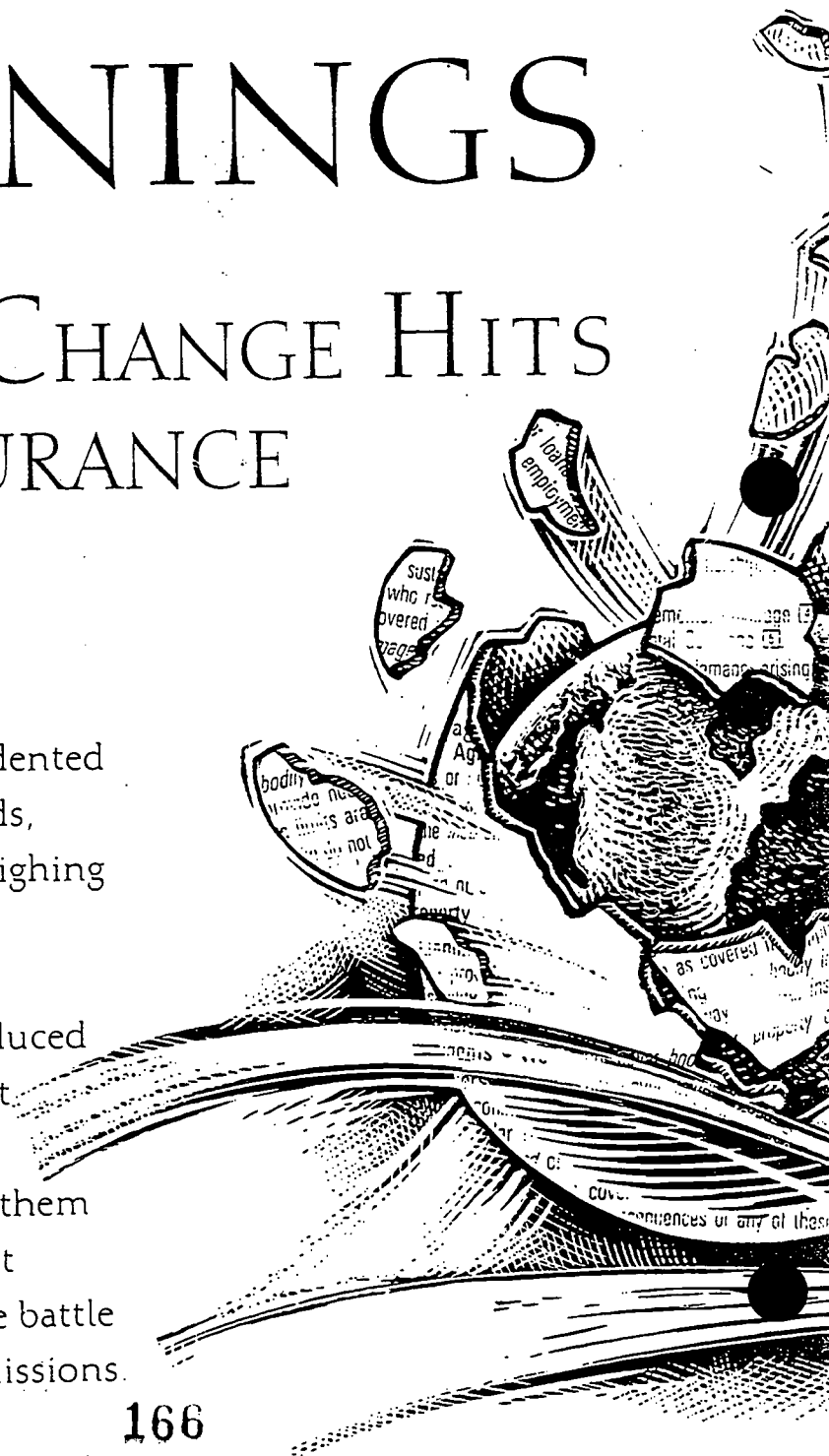
- Flynn, James, Paul Slovic, and C.K. Mertz. 1994. *Gender, race, and perception of environmental health risks*. Eugene, OR: Decision Research. ©1994 reprinted by permission of Decision Research. James Flynn, Paul Slovic, and C.K. Mertz.

- Jones, David. 1993. Environmental hazards in the 1990s: Problems, paradigms, and prospects. *Geography* 78, 2: 161-165. ©1993 reprinted by permission of The Geographical Association. David Jones.

Christopher Flavin. 1994 . Storm warnings: Climate change hits the insurance industry. World Watch 7,6 (November/December): 10-20. ©1994 reprinted with the permission of Worldwatch Institute. Christopher Flavin.

# STORM WARNINGS

## CLIMATE CHANGE HITS THE INSURANCE INDUSTRY



Staggered by an unprecedented series of hurricanes, floods, and fires, insurers are weighing the possibility that these catastrophes are the first real effects of human-induced climate change—and that the worst is yet to come. Their response could pit them squarely against the giant fossil fuel industry in the battle over reducing carbon emissions.

"The cost of inaction is very speculative and remote in time..."

*—Report of a fossil fuel lobby group opposing action to curtail carbon emissions*

"Failure to act would leave the insurance industry and its policyholders vulnerable to truly disastrous consequences."

*—Swiss insurance executive H.R. Kaufman*

ILLUSTRATION BY NANCY RUTH JACKSON

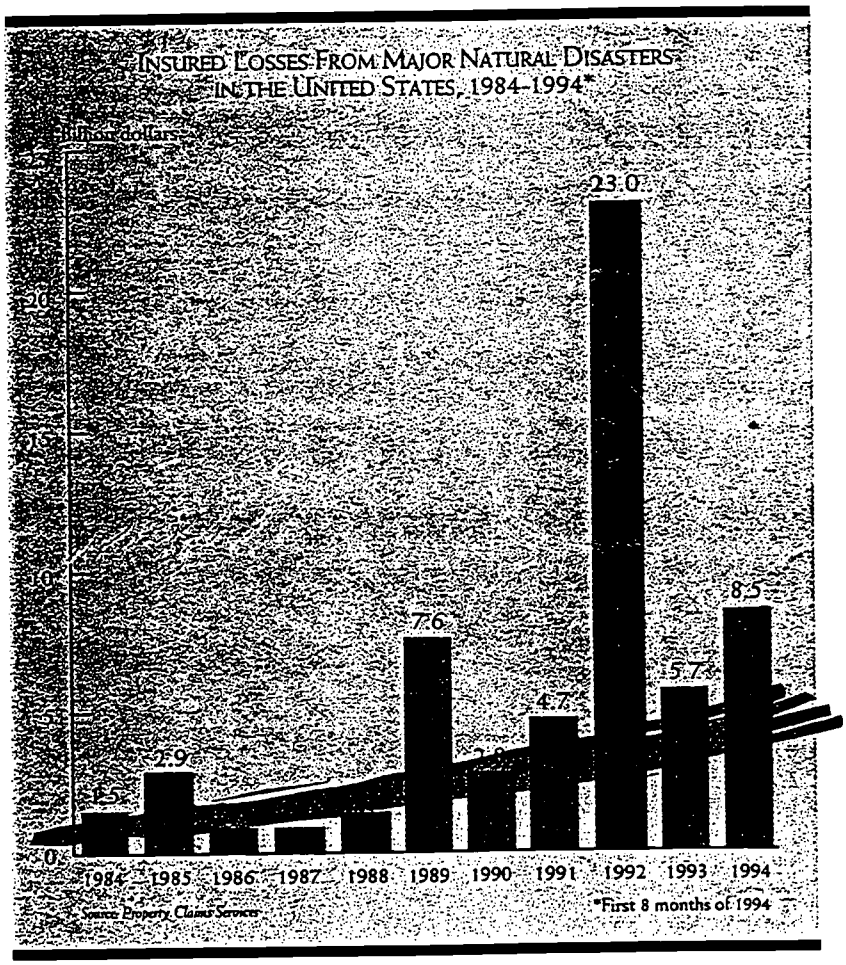
BY CHRISTOPHER FLAVIN

During 1993, a series of headlines in major newspapers described an insurance industry in crisis, as weather-related disasters led to billions of dollars in insurance claims. "Storm Loss New Blow to Insurers," proclaimed *The New York Times*. "As Insurance Costs from Hurricanes Soar, Higher Rates Loom," warned *The Wall Street Journal*. And London's *Financial Times* offered a succinct explanation: "Global Warming Makes Insurers Sweat."

The headlines were hardly an exaggeration. Between September 1989 and September 1994, the world experienced at least 15 separate weather-related disasters in which financial losses exceeded $1 billion. Among the events that created the greatest alarms were Hurricane Andrew, the most damaging storm in U.S. history; several huge

# Will the Next Decade Be Worse Than the Last?

(a) Actual events seem to confirm what the climate models predict.
(b) No one knows for sure.
(c) Insurers can't wait to find out.




cyclonic storms in Asia; a series of ravaging wind storms in northern Europe; two enormously destructive fires in California; and the worst flood ever seen on the Mississippi River.

The very term "natural disaster" suggests that this litany of financial losses should be written off as a bizarre coincidence we can do little about. But a growing body of scientists, as well as experts within the insurance industry itself, are beginning to consider the possibility that human society is not only a victim of climatic events, but a causal agent as well.

In some ways this is inarguable. Coastal housing developments, levees that alter flood plains, and fire suppression programs that allow the buildup of combustible materials all contribute to the frequency or severity of weather-related disasters. But such actions merely increase vulnerability to incidents of extreme weather, once they occur. On a more profound level, scientific evidence now points to the possibility that human-induced changes to the atmosphere may increase the frequency or severity of the incidents themselves—including hurricanes, droughts, and wild fires.

It is too early to know for sure if the recent spate of disasters is related to the ongoing buildup of greenhouse gases in the atmosphere. But people in the insurance industry are looking at the question closely, since their entire business is founded on historically based probability calculations that would have to be overhauled if insurers are no longer able to assume that weather in the future will be similar to past weather. Indeed, a suddenly less stable, more extreme climate could make the world's insurance companies as vulnerable as the flimsiest Caribbean bungalow.

Franklin Nutter, President of the Reinsurance Association of America, sums up his industry's dilemma this way: "The insurance business is first in line to be affected by climate change...it could bankrupt the industry."

The entry of the $1.4 trillion-a-year insurance industry into the debate over global climate change could mark a watershed. Even as national governments and international agencies have begun to focus on strategies to reduce greenhouse gas emissions, public discussions have been shaped in part by the voices of skeptics who argue that because we cannot fully predict the timing or magnitude of

climate change, policy responses should be delayed.

To insurance executives, however, this is a strange argument, since *all* of their business—indeed, its very nature—involves making important investment decisions in the face of large uncertainties. Indeed, they have effective tools for quantifying the financial risk involved in possible future disasters—even if the probability of a particular event is small. To an insurance executive, the very uncertainties associated with climate change may be the best reason for taking it seriously.

## Storm Warning

During the past few years, the world's television screens have been filled with the spectacle of one natural catastrophe after another. A collection of press reports compiled by the environmental group Greenpeace from six continents between 1990 and 1994 displays a remarkable litany of the highest floods, longest droughts, most severe wild fires, and worst heat waves ever recorded. A December 1993 report in *The New York Times* science section summed up many people's' gut reaction in simple terms: "This Year's Weather: It Really Was Strange." That feeling continued in 1994, which witnessed the hottest summer in some parts of Europe since the eighteenth century, and severe droughts throughout East Asia.

Tropical hurricanes, cyclones, and typhoons—as they are variously called in different parts of the world—are among the most widely destructive and life-threatening of natural disasters. These large, swirling storms, which have their genesis in warm tropical waters—in areas such as the Caribbean, South Pacific, and Indian Ocean—can pack winds of between 120 and 300 kilometers per hour, and cause storm surges that inundate low-lying coastal areas.

Since the late eighties, hurricanes have struck various parts of the world with alarming frequency. In May 1991, for example, a "cyclone" with winds of 270 kilometers per hour struck Bangladesh, flooding vast areas of the country's flat coastal plain. An estimated 139,000 people were killed, more than a million homes were damaged or destroyed, and financial losses were put at $1.8 billion—nearly 10 percent of Bangladesh's annual GNP.

Four months later, southwest Japan was struck by the sixth strongest storm ever recorded by the Japan Meteorological Agency. Although it barely missed some of Honshu's most densely populated areas, Typhoon Mireille damaged thousands of homes and yielded nearly $5 billion in financial losses.

Within the next year, at least five devastating tropical storms caused billion-dollar-plus losses in locations ranging from China to Pakistan and Hawaii, where Hurricane Iniki, with sustained winds of 210 kilometers per hour, destroyed 10,000 homes and 70 hotels. Total losses: $2.1 billion. Most recently, in August 1994, China was hit by Typhoon Fred, which killed 700 people and caused $1.6 billion in damage.

> A 3 or 4 degree rise in sea temperatures could increase the destructive potential of hurricanes by 50 percent.

Even amid all these storms, Hurricane Andrew was—from a financial standpoint—the tempest no one will forget. Striking south Florida on August 24, 1992, Andrew packed sustained winds of 230 kilometers (145 miles) per hour and was the third most powerful hurricane to make landfall in the United States in the twentieth century. Missing the region's largest urban centers, Andrew still virtually flattened some 430 square kilometers of Dade County Florida, destroying 85,000 homes and leaving almost 300,000 people homeless.

Total losses from Andrew were estimated at $25 billion, equivalent to the combined losses of the three most costly storms to strike the country previously. Only the warnings of the National Hurricane Center (which was directly hit by the storm) and local officials kept the death toll to just 55.

Tropical storms were not the only natural disasters to cause extensive damage in the past few years. In January and February 1990, for example, northern Europe was hit by an extraordinary series of four devastating windstorms that together caused more than $10 billion in damage. More than 50 million cubic meters of harvestable timber was destroyed in Germany, Austria, Czechoslovakia, Switzerland, and France.

In other parts of the world, floods caused even greater damage. In 1992, a flood in Pakistan killed 5,000, and one in India killed 1,400. In 1994, China was hit by a series of floods that killed 1,600 people and racked up $6 billion in damages. In the United States, the "flood of the century" in 1993 covered 41,000 square kilometers of Mississippi Valley farmland in nine states—more than twice

the area of the Netherlands—and caused $12 billion in damage.

Severe droughts and wild fires have also become common in recent years. California, Spain, Romania, and Queensland, Australia, for example, recently experienced their worst droughts in a century, leading to extensive water rationing. A drought-related firestorm in the hills above Oakland, California in 1991 destroyed hundreds of homes and led to insurance claims of $1.7 billion; fires near Los Angeles in 1993 had similar results. Italy too, had severe forest fires in 1993. And just last summer, fires throughout the western United States destroyed enough timber to send paper prices soaring.

> The chief concern about global warming is not the increase in average temperatures, but the possibility that in the course of heating up, the atmospheric and oceanic systems that regulate the world's weather could be dramatically disrupted.

## The Claims Mount

This series of climate extremes over the past few years has given the insurance industry an unprecedented shellacking. In 1992, total financial losses from weather-related disasters reached a record $23 billion (see graph, page 12). Resulting claims wreaked havoc in the insurance business.

For many companies, Hurricane Andrew was far and away the worst disaster so far, and provoked a profound reappraisal of their business. The Prudential Insurance Company paid out claims of $1.1 billion, Allstate paid $2.5 billion, and State Farm $3.5 billion. Within months, eight insurance companies serving Florida had collapsed, and many others threatened to pull out of the state unless they could be protected from such debacles in the future.

All told, the storm's insurance losses reached $16 billion, or 16 times the total claims for the Loma Prieta earthquake that struck the San Francisco area in 1989. "Insurers used to see Florida as the land of milk and honey and ignored the risk," said Florida Insurance Department spokesperson Jill Chamberlain. "Now, there is fear and trembling."

But while Andrew stunned the insurers, it was only one of a long series of weather-related setbacks. In the United States, in 1993 alone, a winter storm cost $1.8 billion in insured losses, the Midwest floods cost $1 billion (despite limited availability of flood insurance), and the southern California wildfires cost $950 million. Following Hurricane Iniki, several companies temporarily stopped writing policies in Hawaii, and some pulled out of the state altogether. A similar reaction in the Caribbean led the president of the regional insurance association, Orinthia Nesbeth, to proclaim a "state of crisis never before experienced in its history."

The Re-insurance industry, which insures the insurers, was particularly exposed to the combined effects of a dozen huge storms in North America and Northern Europe between 1990 and 1992. Lloyd's of London, for example, suffered losses of $4.4 billion in 1990 and 1991, forcing some 8,000 members of the giant syndicate to resign, and many into bankruptcy. In one description of the debacle, a *Time* magazine reporter wrote, "Lloyd's is reeling, and as the fine print catches up with them, many investors face financial ruin—down to the last cuff link."

Still, many insurance experts are concerned that they may not yet have seen the worst. Meteorologists point out that if Andrew had veered slightly, it would have run straight through Miami and then would have been on track to hit New Orleans a day later. If so, insurance losses might have doubled or tripled. The Florida Insurance Commissioner has said that if New Orleans had been struck, the U.S. insurance industry could have been wiped out.

A more northerly hurricane track could also affect the rapidly developing coastal Carolinas or the even more densely settled areas of New York and New England—as once happened in the thirties, for example. Maurice Greenberg, chairman of American International Group, an insurance company that had hurricane-related claims of $150 million in 1992, told *The New York Times*, "If Andrew had hit the south coast of Long Island, you would no longer have the strongest insurance industry [in the world], you would have the longest insurance industry—some companies would be flat on their backs."

## A Climate of Extremes

Among many scientists, there is growing concern that the world may have entered a period of dangerous climatic extremes. Although we are still in the early stages of human alteration of the atmosphere—greenhouse gas concentrations are rising at a record pace—computerized climate models suggest that these gases are likely to warm the atmosphere in the decades ahead, and may lead to a range of extreme climatic events. Droughts, floods, hurricanes, and fires, for example, could all become more common. Tim Gibson, a meteorologist at the University of Melbourne, speaks for many atmospheric scientists when he says, "It is very difficult to find sustainable evidence that something is getting more severe or erratic, but we believe the greenhouse effect would cause these changes." Indeed, some scientists believe they already are.

In an age when many people live in air-conditioned homes and eat fresh food trucked in from farms located thousands of kilometers away, it is easy to lose awareness of the degree to which we are dependent on a narrowly prescribed range of climatic conditions. People generally live in areas where water is adequate if not abundant, and their nutritional and materials needs are met via agricultural, forestry, and fishery systems that require particular conditions of temperature, rainfall, and humidity.

Indeed, the living patterns and technologies that were built up over centuries to meet human needs have been carefully adapted to the climate. While we can sometimes cope with the effects of an isolated drought, heat wave, or flood by bringing in relief supplies of food or water from other areas, simultaneous disruptions in several regions could be unmanageable.

The chief concern about global warming, therefore, is not the increase in average temperatures, but the possibility that in the course of heating up, the atmospheric and oceanic systems that regulate the world's weather could be suddenly and dramatically disrupted. Areas that now receive ample rainfall might become deserts, regions now safe from catastrophic wind storms and floods could suddenly be vulnerable, and oceanic currents that now moderate both marine and continental climates might unexpectedly shift course.

**Weather-Related Disasters, 1989-1994**

| | Location | Date | Estimated Damages |
|---|---|---|---|
| Hurricane Hugo | North America | September 1989 | $5,800,000,000 |
| Windstorm Daria | Europe | January 1990 | 4,600,000,000 |
| Windstorm Herta | Europe | February 1990 | 1,300,000,000 |
| Windstorm Vivian | Europe | February 1990 | 3,200,000,000 |
| Windstorm Wibke | Europe | February 1990 | 1,300,000,000 |
| Unnamed Cyclone | Bangladesh | May 1991 | 1,800,000,000 |
| Typhoon Mireille | Japan | September 1991 | 4,800,000,000 |
| Oakland Fires | North America | October 1991 | 2,000,000,000 |
| Hurricane Andrew | North America | August 1992 | 25,000,000,000 |
| Cyclone Iniki | Northj America | August 1992 | 1,400,000,000 |
| Winter storm | North America | March 1993 | 1,600,000,000 |
| Mississippi Floods | North America | July/August 1993 | 12,000,000,000 |
| Los Angeles Brush Fires | North America | September 1993 | 10,000,000,000 |
| Spring Floods | China | Spring 1994 | 6,000,000,000 |
| Typhoon Fred | China | August 1994 | 1,600,000,000 |

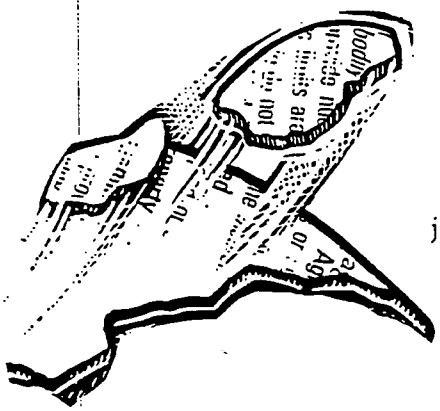
*Source:* Various reports and articles.

One of the most serious consequences of a disrupted climate could be more frequent and severe droughts. From China to the Middle East and North America, water shortages are already impinging on economic development in many regions. In some areas, the availability of water is the main constraint on agricultural production, and the total area of cropland that is irrigated has begun to level off as rivers and underground aquifers are depleted. At the same time, rapidly growing cities are competing for water in many countries.

Although a warmer world climate will tend to boost both precipitation and evaporation, atmospheric models suggest that the regional effects would be extremely uneven, and that some areas

that now receive plentiful rainfall might become substantially drier. As Sandra Postel of the Global Water Policy Project notes, "Both water and food security will be more elusive for the next generation without rapid action to stabilize atmospheric greenhouse gases."

Interior areas of China and the North American Midwest, for example, both of which are important food-growing areas, are projected to receive less average rainfall and to suffer more frequent droughts. At the same time, more frequent summer heat waves would boost evaporation, drying out crops even more, while impeding pollination. Although some optimists argue that farmers could just move their crops farther north, most of these areas are either already cropped or lack the rich soils and other conditions needed to support bumper crops. Moreover, drought-resistant varieties often have lower yields.



Increased frequency of droughts and heat waves could have other adverse effects. Most forests are adapted to particular regimes of moisture and temperature, and climate change could put vast areas of timber in jeopardy. Over time, the trees would become more susceptible to insect infestation or disease—a phenomenon already apparent in the Appalachian region of North America and the Alpine forests of Europe, though to what extent these ravages are due to climatic change as opposed to acid rain or other causes is unclear. In any case, sick or dying forests become more vulnerable to catastrophic wild fires, so the loss of forest cover can occur quite suddenly. While new tree species could in theory spring up to replace the dead forests, it would be difficult for any new ecosystem to get established if the climate continues to change rapidly, or becomes more erratic.

A warming of the world's atmosphere could also increase the frequency and severity of major storms, according to some climate experts. A scientific assessment done for the German insurance company Munich Re notes, "A warmer atmosphere and warmer seas result in greater exchange of energy and add momentum to the vertical exchange processes so crucial to the development of tropical cyclones, tornadoes, thunderstorms, and hailstorms."

Hurricanes and typhoons, for example, can only form over tropical waters that are at a temperature of at least 26 degrees C. Meteorologist Kerry Emanual of the Massachusetts Institute of Technology estimates that the 3 to 4 degree Celsius rise in sea temperatures projected by some atmospheric models could increase the destructive potential of hurricanes by 50 percent and cause sustained storm winds as high as 350 kilometers (220 miles) per hour.

Donald Friedman, former director of the Natural Hazards Research Program for the Travelers Insurance Company, calculates that such a warming would lengthen the hurricane season in North America by two months or more, and allow the storms to move farther north before petering out. In future decades, it might be as common for New York or Boston to be pounded by a devastating hurricane as it now is for Galveston or Miami—boosting average annual hurricane losses for the U.S. insurance industry by 40 percent.

These losses could be further multiplied by another feature of a warming world: rising seas. Water expands as it warms, and the higher temperatures will also tend to melt the glacial ice found near the world's poles. As a result, scientists now believe that by late in the next century the oceans could rise at least half a meter above the current sea level.

Such an increase would threaten scores of coastal communities, as well as the estuaries, freshwater aquifers, and other resources on which societies depend. In Galveston, a one-meter sea level rise would place virtually the entire city within the 100-year floodplain, and in Charleston, South Carolina, 60-percent of the city would be flooded on average every decade.

The U.S. Environmental Protection Agency estimates that the cost of protecting the U.S. coastline from rising seas over the next several decades could range from $32 to $309 billion. But many areas of the world would not be able to pay such bills. In Bangladesh, where millions of people have no choice but to live in areas vulnerable to flooding—some 300,000 people lost their lives in a 1970 typhoon—the results could be particularly devastating.

As this example indicates, developing countries are likely to be the most vulnerable to climatic extremes. Their expanding populations are often forced to live in vulnerable areas, and funds are

often insufficient to provide for protection of farmland or homes or even to rapidly evacuate threatened areas. Moreover, most people in poor countries cannot afford insurance of any kind.

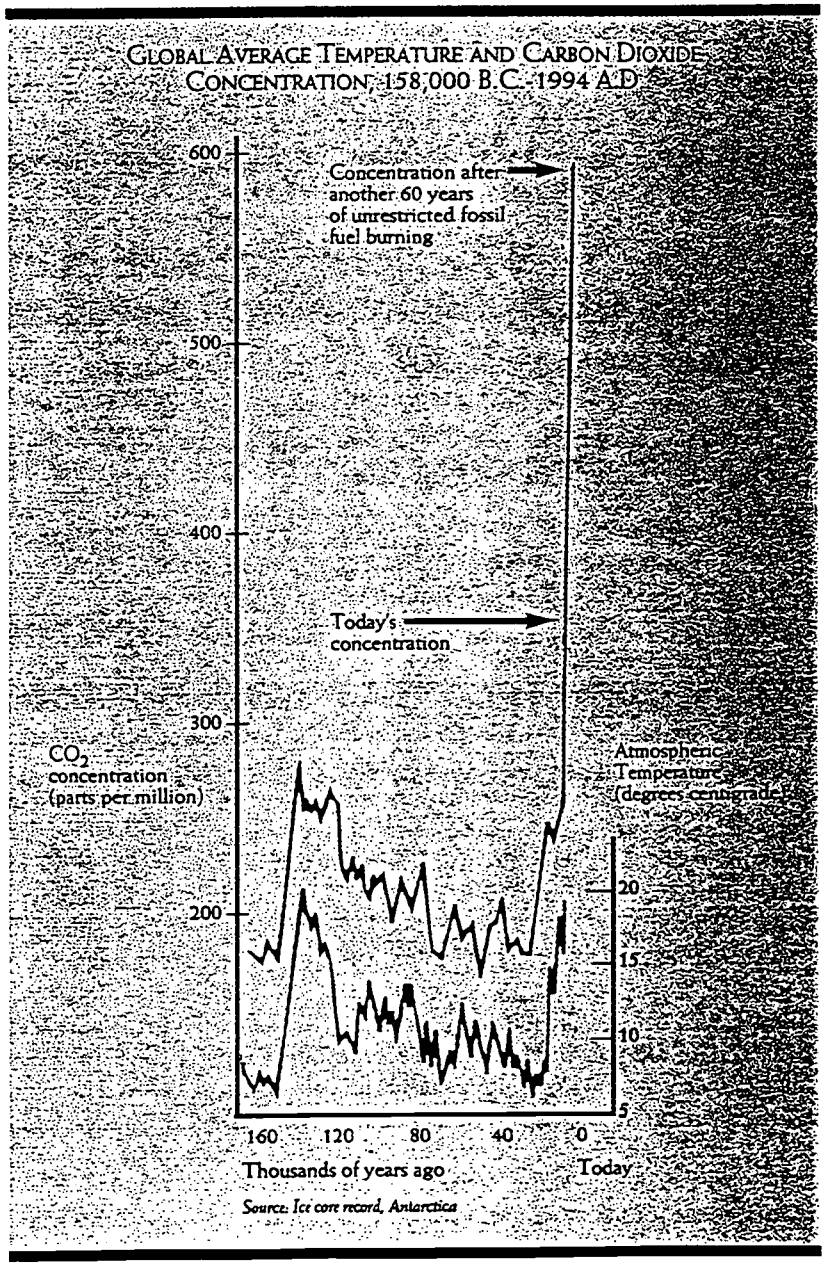
## The Great Climate Debate

Although no scientist knows with absolute certainty whether the recent spate of natural disasters is an early warning sign of a changing climate, increased concern about the potential for climatic extremes and their likely impact on the insurance industry has opened an important new front in the "great climate debate" that has raged since the late 1980s.

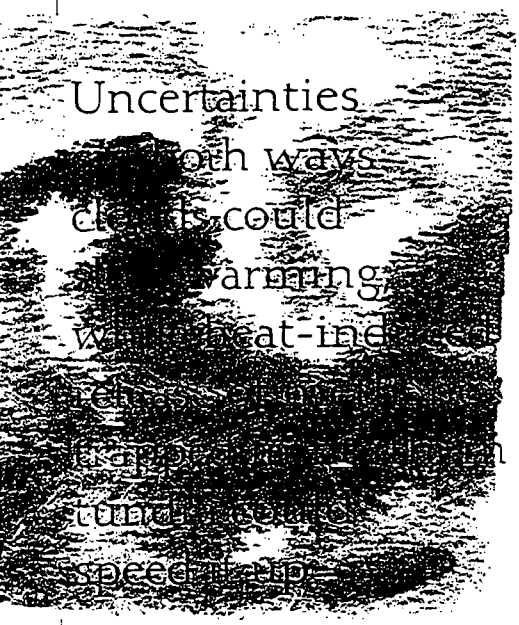
For the average citizen, the climate debate often seems hopelessly confused. One day's newspaper announces that the world just experienced the warmest year ever recorded, and the next day says that in North America, the last year was only about average. On talk shows, "experts" endlessly debate the question of climate change: one claiming that it is the greatest threat facing humanity, and the other saying that it is something trumped up by tree-hugging scientists and U.N. bureaucrats looking to expand their mandate.

Although most scientists endorse the official U.N. projection of a likely warming of global temperatures, scientific dissenters have emphasized the remaining uncertainties, and said that until these are removed, the world should avoid taking serious steps to reduce greenhouse gas emissions. Patrick Michaels of the University of Virginia, for example, argues that the climate record shows a slower rate of warming than the models suggest, that increasing cloud cover may mitigate the effects of greenhouse gases, and that even if the climate were to change, the effects would be manageable.

Such arguments have caused policymakers to hesitate. Consequently, of the 159 nations that signed the Framework Convention on Climate Change at the Earth Summit in 1992, few have come up with national action plans that would significantly reduce emissions. Meanwhile, emissions—and atmospheric concentrations—of carbon dioxide continue to mount (see graph, below).



Getting to the bottom of the uncertainty debate and better understanding climatic extremes is therefore central to breaking the impasse on climate policy. Even critics of the scientific consensus do not claim that they know for sure that the world will not experience a dangerous warming if we go on adding greenhouse gases to the atmosphere. So, the central question—whether we should continue waiting until we *do* know with certainty how the climate will change before taking action—is as much financial and philosophical as it is scientific.




Although the idea of making decisions based on such uncertainty may seem problematic, it is important to remember that few political decisions even on issues such as whether to go to war—are based on complete foreknowledge of the future. And for at least one business group, probabilistic assessments of the future are the basis on which billion-dollar decisions are regularly made. That group is the actuaries and executives who run the world's insurance companies.

Insurance is by its nature a game of chance. Actuaries figure out what the odds are of a given house burning down—one in 10,000, say—and then charge just enough for fire insurance so that the premiums on 10,000 homes, and the resulting investment income, will pay for losses on the one that burns, with enough left over for overhead costs and profits.

For an insurance actuary, then, the fact that scientists cannot predict with certainty how the climate will change is neither particularly unusual nor a reason for delaying action. Future disasters are always uncertain, and as long as actuaries can assign a rough probability to a potential calamity and estimate the magnitude of potential damages, then they have a basis for taking action. To the insurance industry, the idea that one should only assign dollar values to things that are certain is nonsensical.

A growing number of climate scientists are addressing the issue in similar terms. The U.N.'s International Panel on Climate Change (IPCC), for example, acknowledges the uncertainties in current climate models, and its reports include a range of scenarios. Those uncertainties cut both ways, however: clouds could slow warming, while heat-induced release of methane trapped in the northern Tundra could cause global warming to proceed more rapidly.

Similarly, the scientific models on which the original agreements to protect the ozone layer were based turned out to be inadequate, failing for example to predict the crucial ozone hole over Antarctica. Ozone depletion turned out to be a more severe problem than most nations thought, and because the initial responses were modest, the later ones had to be more drastic—phasing out CFC production in just a decade. In a recent report, IPCC scientists concluded that "our imperfect understanding of climate processes...could make us vulnerable to surprises."

## Insuring Against Disaster

As claims mounted in the early nineties, insurance executives began to consider their vulnerability to climate change. Scientists were consulted, meetings were held, and many companies prepared internal reports on the issue. H.R. Kaufman, the General Manager of Swiss Re, one of Europe's largest insurance companies, says, "There is a significant body of scientific evidence indicating that last year's record insured loss from natural catastrophes was not a random occurrence.... Failure to act would leave the [insurance] industry and its policyholders vulnerable to truly disastrous consequences."

A growing number of insurance executives now believe that the nature of their business puts them inevitably on the front lines of the climate problem: if global warming leads to weather-related disasters, the insurance industry will be expected to absorb the resulting financial shocks. Among the insurance organizations that have held high-level meetings on the climate issue are Tokyo Marine and Fire and the British Insurance Association.

A recent report by the Reinsurances Offices Association said, "Even a cursory glance at some of the basic principles of reinsurance reveals the concern that ought to exist about the greenhouse scenario.... If ever there was a case for moving the goal post this is it."

The dilemma for insurance companies is that their

rates and coverage are based on averages. In the case of weather-related coverage, they look to past climate trends and assume that over time, the frequency of catastrophes will be the same. But in a world of changing and unpredictable weather, such calculations have little value. A spokesman for Allstate says, "We purchased our catastrophe protection based on the company's historical loss record before Andrew happened....We're reassessing that protection now."

Indeed, some industry experts believe that another "bad year" or two, or even a particularly catastrophic single storm, could force a number of major companies into bankruptcy. Ake Munkhammar of Sweden's large Skandia insurance company observed, "Even if the meteorologists talk about normal variations over the centuries, a company cannot reason that way."

As a first step, many companies are reducing their exposure in coastal real estate (known as "shore-lining"), wildfire-prone regions, and valleys where floods are possible. Already, many companies appear to have cut their coverage in areas such as the Caribbean and Hawaii, creating an insurance crisis. Although this is a logical strategy for individual insurance companies, it may not suffice. Climate change is inherently unpredictable, and insurance companies will never know with complete confidence how to account for it.

There is also a real danger that insurance bankruptcies and abandonment of property protection in high-risk areas could increase the vulnerability of many communities. In the past, societies have effectively used insurance as a buffer against extreme events, a buffer that would be even more important in a world of changing climates and more frequent natural disasters.

If the insurance industry solves its vulnerability problem simply by abandoning certain forms of protection, then either tax-payers will have to bail out disaster victims, or individual citizens will be forced to pay the price—which in many cases means the loss of virtually everything they own.

## The Coming Climate Convention

As a business that is on the frontlines of society's most risky activities, the insurance industry has a century-long tradition of spurring important social policy changes to help reduce those risks. In the United States, for example, the industry's experience with massive fire-related claims led it to point out that stricter building codes could reduce the frequency of fires. Insurers then played a leading role in lobbying governments to adopt such codes.

Similarly, these companies have fought since the early 1970s for tougher safety standards for automobiles—often battling directly with auto industry lobbyists. The resulting requirements for crash-resistant bumpers, seatbelts, and airbags have saved tens of thousands of lives, and avoided billions of dollars in insurance losses.

With this history in mind, insurance industry leaders such as Frank Nutter of the Reinsurance Association of America now argue that insurers should take a more direct role in the climate change issue. For example, in a 1993 report, the German reinsurance company Munich Re stated, "Action is now required first and foremost from politics and business: the imminent change in our climate makes speedy, radical countermeasures unavoidable."

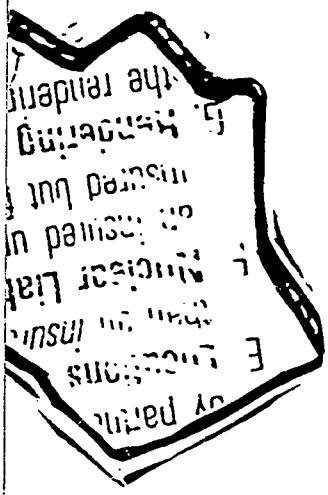
Many companies are reducing their exposure in coastal real estate, wildfire-prone regions, and valleys where floods are possible

One useful role for the insurance industry would be to build on its advocacy of building codes, which it relies on to reduce the frequency and severity of fire, wind, and water damage. Insurance companies could, for example, encourage governments to tighten the energy efficiency codes on buildings, and so reduce carbon dioxide emissions. Some codes—such as requiring weather stripping or double-glazed windows—can both save energy and reduce the potential for short-term weather damage.

Insurance companies' investment portfolios provide additional leverage. If they were to dump some of their stocks in oil and coal companies, or actively invest some of their funds in new, less carbon-intensive energy technologies (forming a sort of climate venture fund), insurance companies could spur the development of a less threatening energy system. Such a shift would not be all that unusual; some health insurers, for example, recently sold their stock in tobacco companies, whose business is incompatible with insurance companies' interest in a healthier population.

The next step for insurance companies is an unfamiliar one—into the arena of greenhouse politics. This is turf that is at least partly occupied by the very industries that cause the greenhouse problem—the major producers and users of fossil fuels. Throughout the past five years of climate negotiations, the oil and coal lobbies have played an active role, clinging tenaciously to the argument that the world does not yet know enough about the rate or effects of global warming to invest significant sums in slowing it.

According to a statement by the National Coal Association in the United States, for example, "The issue remains shrouded in controversy, intrigue and misunderstanding.... Scientific knowledge does not justify drastic steps to restrict the use of coal and other fossil fuels." Another fossil fuel lobby, the Global Climate Coalition, stated in a 1994 report, "The cost of inaction is very speculative and remote in time.... We run the risk of implementing inappropriate policies that later turn out to have been misguided."



Although opposed by environmental groups which argue that investments in energy conservation and tree planting can be highly cost-effective means of reducing net greenhouse emissions, the arguments of the fossil fuel lobby—often mis-characterized in the media as the voice of industry as a whole—have helped dissuade most governments and international agencies from taking serious steps to re-orient their energy policies. The Framework Convention on Climate Change, agreed to in Rio de Janeiro in 1992, includes no binding requirements on signatories, though several governments are now discussing protocols to make it tougher.

Although many industrial countries have pledged to hold their greenhouse gas emissions to the 1990 level in the year 2000, most of the climate plans developed so far are limited to voluntary programs such as increased funding of energy-saving projects and stepped up research and development. Few include the more crucial steps of reducing the large subsidies to fossil fuel burning, or levying new carbon taxes to discourage the use of those fuels. As a result, even with new plans in place, the United States, Japan, and the European Union—which together account for roughly 40 percent of the world total—all project increases in their carbon emissions during the 1990s.

The first Conference of the Parties to the Climate Convention will convene in Berlin in March 1995, and as it approaches, the need for a political breakthrough on the climate issue is becoming clear. If the huge ($1.5 trillion per year) fossil fuel industry is the only industrial lobby that actively engages in the climate battle, it is likely to prevail—and progress in addressing the global climate dilemma will continue to stall.

Few industries are capable of doing battle with the likes of the fossil fuel lobby. But the insurance industry is. On a worldwide basis, the two are of roughly comparable size—and potential political clout.

During the past year, the insurance industry has been getting strong encouragement from environmentalists such as British scientist Jeremy Leggett to enter the greenhouse fray. Leggett calls for "solidarity among the risk community"—ranging from insurers to environmental groups—and "active strategic protection of the market in which [the insurance industry] operates." In this effort, the insurance industry would have some natural allies: at recent climate negotiations, active caucuses were formed to represent two groups with an active interest in strong climate policies—small island states threatened by rising seas, and businesses with an interest in less carbon-intensive energy sources such as natural gas and renewable energy.

The worldwide insurance industry has as much to gain from a strong global climate agreement as the fossil fuel industry has to lose. And unless it more actively engages the struggle over climate policy, the insurance industry's future is likely to be stormy indeed.✦

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March 16, 1994

# Gender, Race, and Perception of Environmental Health Risks

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Abbreviated Title: Gender, Race, and Perception of Risks

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*Note: Tables and figures referred to in this article appear in the appendix.

March 16, 1994

# Gender, Race, and Perception of Environmental Health Risks





ABSTRACT

This paper reports the results of a national survey in which perceptions of environmental health risks were measured for 1275 white and 217 nonwhite persons. The results showed that white women perceived risks to be much higher than did white men, a result that is consistent with previous studies. However, this gender difference was not true of nonwhite women and men, whose perceptions of risk were quite similar. Most striking was the finding that white males tended to differ from everyone else in their attitudes and perceptions—on average, they perceived risks as much smaller and much more acceptable than did other people. These results suggest that sociopolitical factors such as power, status, alienation, and trust are strong determiners of people's perception and acceptance of risks.

KEY WORDS: Gender; race; risk perception; environmental equity.

## 1. INTRODUCTION

Research has demonstrated that perceptions of risk are influenced by the qualities of a hazard—whether exposure to it is voluntary or controllable, whether its adverse consequences can be catastrophic, whether its benefits are distributed fairly among those who bear the risks, and so on.[1] Few studies, however, have examined in any detail the characteristics of the risk perceivers themselves. One exception is that sizable differences between risk perceptions of men and women have been documented in several dozens of studies. Men tend to judge risks as smaller and less problematic than do women.[2-13]

More recently, race and risk have become an issue as it has become apparent that people of color are subjected to higher levels of exposure from many toxic substances.[14] The conditions leading to these disproportionate exposures have been labeled "environmental racism."[15] There is little data, however, regarding how people of color perceive the risks to which they are exposed.

A recent survey of the American public's perceptions of risk interviewed more than 200 people of color. The present study reports the results of this survey, with particular emphasis on the relationships among race, gender, and risk perceptions.

## 2. METHOD

The data for the present study comes from a national survey in the United States in which a random sample of 1512 English-speaking persons were interviewed by telephone. The interviews were conducted between November 21, 1992 and January 16, 1993. The response rate was 50.7%. The objective of the study was to obtain information on people's





attitudes, perceptions, values, knowledge, and beliefs pertaining to environmental health risks. The survey instrument contained 155 items including ratings of environmental risks, attitude and opinion questions on a variety of health issues such as the riskiness of one's local environment, attitudes toward government and business, general attitudes called *worldviews*, personal risk-taking behaviors, and personal and demographic characteristics of the respondents and their households.

Race and ethnicity were combined in one question for the survey: "What is your race or ethnic background? Do you consider yourself Hispanic, White, Black, Asian, or American Indian?" Twenty-three persons did not answer this question on race/ethnicity. Those who did answer were distributed as shown in Table I.

Insert Table I about here

The characteristics of the present sample can be compared roughly to the data from the U.S. Bureau of the Census *1990 Census of Population*, which assessed 93 million households. White households made up 86.0% of this total, blacks 11.3%, and other nonwhites 2.8%. Hispanics (who can be of any race) were 6.3% of the households. Population counts may differ from household counts because of different living arrangements and household sizes across race and ethnic categories. Therefore, population estimates for race and ethnicity are complex and inexact, especially when they are combined.[16, 17] Taking these considerations into account, our survey sample may have a slightly higher percentage of whites than the general population. Because the nonwhite respondents were required to be

English-speaking persons, they may be somewhat more similar to whites than the general nonwhite population would be.

## 3. RESULTS

Respondents were asked to rate the health risks associated with each of 25 hazards. These hazards included a diverse set of technologies (e.g., nuclear power, commercial air travel), lifestyle risks (e.g., cigarette smoking, drinking alcohol), and environmental conditions (e.g., ozone depletion, radon). The response scale went from "almost no health risk," to "slight health risk," "moderate health risk," and "high health risk." These response categories were coded 1 - 4, respectively, and the coded scores were averaged across respondents and across hazards in the analysis reported below.

Table II shows the mean scores for the total sample and for subgroups defined by race and gender. A *hazard index* was created by averaging the ratings across the 25 items. An omnibus F test was conducted for each hazard item to evaluate the statistical significance of differences among the four subcategories of race and gender (white male, white female, nonwhite male, and nonwhite female). As shown in Table I, those who identified themselves as Hispanic, Black, Asian, or American Indian were included in the nonwhite category. For those cases where the omnibus F test was significant at $p < .05$, a Tukey test was conducted. The pairs of groups that differed significantly ($p < .05$) on the Tukey test are identified by code (a - f) as defined in the note to the table. The means for each of the four race/gender subgroups also are presented in Figure 1.

Insert Table II and Figure 1 about here





The data in columns 2 and 3 of Table II show the consistent difference between risk perceptions of men and women that has been documented in previous studies. Columns 4 and 5 of the table show that the nonwhite respondents had consistently higher mean ratings of perceived risk than the whites. This, to our knowledge, is a new finding. But the most striking result in these data is clear immediately from a glance at Figure 1. White males produced mean risk-perception ratings that were consistently much lower than the means of the other three groups. Nonwhite males and females showed only one significant difference (males have lower ratings on stress). Nonwhite males often had higher mean ratings than white females (significantly higher for genetically engineered bacteria).

Nonwhite females tended to have higher mean risk ratings (significantly different statistically from white females on 10 of the items). White and nonwhite males differed significantly on 20 of the 25 items. Significant differences were observed for all 25 items between white males and white females and between white males and nonwhite females.

### 3.1. Risk Perception and Gender

Figure 2 provides another perspective on the gender differences by showing the percentage of men and women who rated a hazard as a "high risk." All differences are to the right of the 0% mark, indicating that the percentage of high-risk responses was greater for women on every item.

Many earlier studies have found that women see risks as higher than men for nuclear technologies: nuclear power, nuclear waste, and nuclear weapons. In the present survey, perceptions of risk are higher for women for every hazard studied. This parallels a recent

Canadian study in which women provided higher risk ratings for 37 of 38 hazards studied (heart pacemakers were the sole exception), including all of the items shown in Figure 2.[9]

A number of hypotheses have been put forward to explain the differences in risk perception between men and women. One approach has been to focus on biological and social differences. For example, women have been characterized as more concerned about human health and safety because they give birth and are socialized to nurture and maintain life.[12] They have been characterized as physically more vulnerable, for example to violence such as rape, and this may sensitize them to other risks.[18, 19] The combination of biology and social experience has been put forward as the source of a "different voice" that is distinct to women.[20, 21]

A lack of knowledge and familiarity with science and technology has also been suggested as a basis for these differences, particularly with regard to nuclear and chemical hazards. Women are discouraged from studying science and there are relatively few women scientists and engineers.[22] Firestone[23] suggests that women may distrust what are perceived as male-dominated technologies. However, this does not explain why the difference extends to nontechnological hazards (e.g., AIDS, alcohol). Moreover, Barke, Jenkins-Smith, and Slovic[24] have found that women physical scientists perceive risks from nuclear technologies as higher than do men physical scientists. Certainly these women scientists are knowledgeable about technology.

In general, these explanations have attempted to determine what makes women different and to understand how conditions of biology, risk experience, socialization, or psychology account for the unwillingness of women, when compared to men, to accept the





levels of risk recommended by advocates and managers of technology. In this context, we note that risk-acceptance advocates are predominantly white males.

### 3.2. Risk Perception and Race

The practice of siting hazardous and noxious waste facilities in areas with significant or majority nonwhite population has led to concerns about environmental equity and environmental racism.[14-15, 25-26] Low income, low levels of education, and other social disadvantages tend to characterize many of these communities. Thus racial and ethnic factors are combined with economic vulnerabilities and political weakness as characteristics of communities that may be targeted as sites for facilities that are unacceptable in other locations.

The environmental and health-risk concerns expressed by people of color are not restricted to the siting of new facilities. Other important issues include pollution of residential neighborhoods and hazards in the workplace, for example, pesticide exposures to agricultural workers.[27] Exposure to lead and the incidence of lead poisoning have been called one of the nation's most serious health threats to children and one that is much more common for children of color than for white children.[28] Federal programs to clean up existing Superfund sites may favor white communities in preference to addressing the problems in communities with large nonwhite populations.[29] In response to one statement in the present survey, "There are serious environmental health problems where I live," 45% of the white respondents agreed or strongly agreed. The rate of agreement for nonwhites was 20.5% higher.

The difference between whites and Blacks was even greater, 25.8%. Hispanics agreed 4.4% more frequently than Blacks and 30.2% more frequently than whites.

Researchers active in the study of environmental justice have viewed the forced physical association by people of color with a wide range of environmental hazards as evidence of structural racism.[15] The dangers of violence, drugs, alcohol, and lower socioeconomic status compound the risks, leading to considerably higher mortality for nonwhites.[30]

The concern about technological and environmental health risks shown by people of color is clearly documented in the present survey data. Figure 3 shows the difference between white people and people of color in rating the hazard items as "high health risks" to the American public. The percentage of high-risk responses is greater among people of color on every item. Nonwhites were particularly more concerned about bacteria in food, genetically engineered bacteria, pesticides in food, and pollution from chemical and nuclear wastes. The differences were smaller for stress, ozone depletion, and outdoor air quality. The differences between white and nonwhite respondents might have been even greater if nonwhites had been asked to rate the risks to people like themselves, rather than to the American public as a whole.

Insert Figure 3 about here

### 3.3 Risk Perception Among White Males

The difference between white males and all other respondents in use of the high-risk response is shown in Figure 4. White males were always less likely to rate a hazard as





posing a "high risk." This was particularly true for suntanning, stress, nuclear power plants, nuclear waste, drinking alcohol, and ozone depletion. This tendency was smallest for video display terminals and medical x-rays.

Insert Figure 4 about here

Whereas Figure 4 reflects high risk responses, we have shown earlier in Figure 2 that white males have substantially lower mean responses on the risk-perception questions—both for individual items and for the 25-item hazard index. When we examined the entire distribution of scores on the hazard index, we observed that white males accounted for more than two-thirds of the respondents in the lower quartile of that distribution, but that some white males were also found in the high-risk perception portion of the distribution. This prompted us to ask, "What differentiates those white males who are most responsible for the 'white-male effect' from the rest of the sample, including other white males who see risks as relatively serious?"

To answer this question, we selected a subgroup of 246 white males at the low-risk end of the hazard index to compare with the 370 other white males and the 873 females and nonwhite males in the sample. The number 246 was arrived at by starting with the lowest-scoring white male on the hazard index and moving up the distribution, adding white males until the mean score on the hazard index for the remaining white males matched the mean score for all other persons (all females and all nonwhite males) in the sample. This occurred when 246 white males were selected for the low-risk perception white male subgroup.

We next compared the attitudes of these 246 white males with the attitudes of the 1243 other respondents in our sample. This comparison group of other respondents included 101 white females, 16 nonwhite males, and 7 nonwhite females with scores on the hazard index that were lower than the score of the highest scoring person in the subgroup of 246 white males.

The group of white males with the lowest risk-perception scores were better educated (42.7% college or postgraduate degree vs. 26.3% in the other group), had higher household incomes (32.1% above $50,000 vs. 21.0%), and were politically more conservative (48.0% conservative vs. 33.2% in the other group).[1] There was no difference between this white male subgroup and the others with regard to age.

Turning to attitudes, the low-risk perception subgroup of white males were *more likely* than the others to:

- Agree that future generations can take care of themselves when facing risks imposed upon them from today's technologies (64.2% vs. 46.9%).
- Agree that if a risk is very small it is okay for society to impose that risk on individuals without their consent (31.7% vs. 20.8%).
- Agree that science can settle differences of opinion about the risks of nuclear power (61.8% vs. 50.4%).
- Agree that government and industry can be trusted with making the proper decisions to manage the risks from technology (48.0% vs. 31.1%).
- Agree that we can trust the experts and engineers who build, operate, and regulate nuclear power plants (62.6% vs. 39.7%).





- Agree that we have gone too far in pushing equal rights in this country (42.7% vs. 30.9%).
- Agree with the use of capital punishment (88.2% vs. 70.5%).
- Disagree that technological development is destroying nature (56.9% vs. 32.8%).
- Disagree that they have very little control over risks to their health (73.6% vs. 63.1%).
- Disagree that the world needs a more equal distribution of wealth (42.7% vs. 31.3%).
- Disagree that local residents should have the authority to close a nuclear power plant if they think it is not run properly (50.4% vs. 25.1%).
- Disagree that the public should vote to decide on issues such as nuclear power (28.5% vs. 16.7%).

In sum, the subgroup of white males who perceive risks to be quite low can be characterized by trust in institutions and authorities and a disinclination toward giving decision-making power to citizens in areas of risk management.

### 3.4. Analysis of Other Social and Demographic Variables

Gender and race are correlated with other variables such as income, education, perceived control over health risks, political orientation, and so on. Can the observed association between race, gender, and risk perception be explained by these other variables? To answer this question, we conducted a number of stepwise multiple regression analyses in which these other variables plus age, perceived importance of technology, and the presence

of children in the household, were forced into the equation to predict the hazard index before either gender, race, or "white male" were put into the equation. The results are shown in Table III.

Insert Table III about here

Gender, race, and "white male" remained highly significant predictors of the hazard index, even when all of these other variables were controlled statistically. Moreover, the standardized regression coefficients for gender, race, and "white male" were reduced very little by the inclusion of the other variables into the prediction equation. To the extent that this analysis adequately controlled for factors such as income, education, and so on, these results show that these factors do not account for the observed effects of race and gender on perceived risks.

## 4. DISCUSSION

There are two new and important results in these data. First, nonwhite males and females are much more similar in their perceptions of risk than are white males and females. Second, white males stand out from everyone else in their perceptions and attitudes regarding risk. These results raise new questions. What does it mean for the explanations of gender differences when we see that the sizable differences between white males and white females do not exist for nonwhite males and nonwhite females? Why do a substantial percentage of white males see the world as so much less risky than everyone else sees it?





Obviously, the salience of biology is reduced by these data on risk perception and race. Biological factors should apply to nonwhite men and women as well as to white people. The present data thus move us away from gender and toward sociopolitical explanations. Perhaps white males see less risk in the world because they create, manage, control, and benefit from so much of it. Perhaps women and nonwhite men see the world as more dangerous because in many ways they are more vulnerable, because they benefit less from many of its technologies and institutions, and because they have less power and control. However, our survey data do not allow us to fully test these alternative explanations. Further research is needed, focusing on the role of power, status, alienation, trust, and other sociopolitical factors, in determining perception and acceptance of risk.

Inasmuch as these sociopolitical factors shape public perception of risks, we can see why traditional attempts to make people see the world as white males do, by showing them statistics and risk assessments, are unlikely to succeed. The problem of risk conflict and controversy goes beyond science. It is deeply rooted in the social and political fabric of our society. Our analysis points to the need for a fairer and more equitable society, as well as for fairer processes for managing risk. If we create such a society, environmental racism will give way to environmental equity.

## ACKNOWLEDGMENTS

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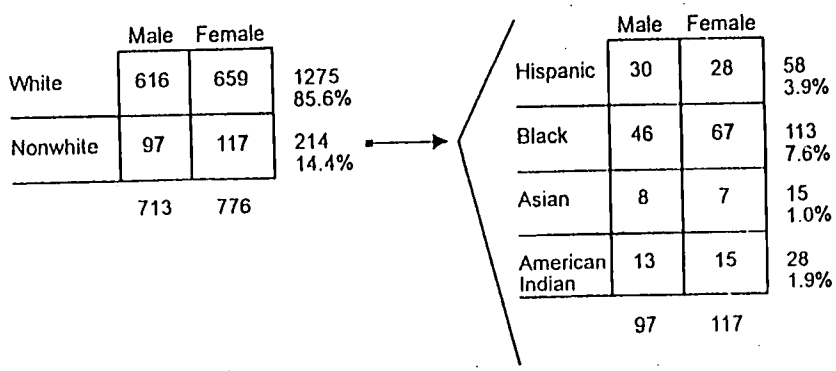


Table I. Survey sample by gender and race.







Table II. Perceived Risk to American Public by Gender and Race (Mean Scores)

| Hazards | Overall[a] | Male | Female | White | Nonwhite | White Male | White Female | Nonwhite Male | Nonwhite Female | Tukey Post-Hoc Paired Comparison[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| Street Drugs | 3.5 | 3.4 | 3.6 | 3.5 | 3.7 | 3.4 | 3.6 | 3.7 | 3.7 | a, b, c |
| Cigarette Smoking | 3.5 | 3.4 | 3.6 | 3.5 | 3.6 | 3.4 | 3.6 | 3.6 | 3.7 | a, c |
| AIDS | 3.5 | 3.4 | 3.6 | 3.5 | 3.6 | 3.4 | 3.6 | 3.5 | 3.7 | a, c |
| Stress | 3.4 | 3.3 | 3.6 | 3.4 | 3.5 | 3.3 | 3.6 | 3.4 | 3.6 | a, c, d, f |
| Nuclear Waste | 3.4 | 3.2 | 3.5 | 3.3 | 3.6 | 3.2 | 3.5 | 3.6 | 3.7 | a, b, c |
| Chemical Pollution | 3.3 | 3.2 | 3.4 | 3.3 | 3.5 | 3.2 | 3.4 | 3.4 | 3.6 | a, b, c, e |
| Suntanning | 3.2 | 3.1 | 3.4 | 3.2 | 3.3 | 3.0 | 3.4 | 3.2 | 3.4 | a, c |
| Ozone Depletion | 3.2 | 3.1 | 3.4 | 3.2 | 3.3 | 3.0 | 3.4 | 3.4 | 3.4 | a, b, c |
| Drinking Alcohol | 3.2 | 3.1 | 3.3 | 3.2 | 3.6 | 3.1 | 3.3 | 3.4 | 3.4 | a, b, c |
| Motor Vehicle Accidents | 3.2 | 3.1 | 3.3 | 3.2 | 3.3 | 3.1 | 3.3 | 3.2 | 3.4 | a, c |
| Pesticides in Food | 3.1 | 3.0 | 3.2 | 3.0 | 3.4 | 2.9 | 3.2 | 3.3 | 3.4 | a, b, c, e |
| Outdoor Air Quality | 3.0 | 2.9 | 3.1 | 3.0 | 3.1 | 2.9 | 3.1 | 3.2 | 3.1 | a, b, c |
| Blood Transfusions | 2.9 | 2.7 | 3.0 | 2.8 | 3.2 | 2.7 | 3.0 | 3.0 | 3.3 | a, b, c, e |
| Climate Change | 2.9 | 2.7 | 3.0 | 2.8 | 3.1 | 2.7 | 3.0 | 3.2 | 3.1 | a, b, c |
| Nuclear Power Plants | 2.9 | 2.7 | 3.1 | 2.8 | 3.1 | 2.6 | 3.1 | 3.0 | 3.2 | a, b, c |
| Coal/Oil Plants | 2.8 | 2.7 | 2.9 | 2.8 | 3.0 | 2.7 | 2.9 | 3.1 | 3.0 | a, b, c |
| Bacteria in Food | 2.8 | 2.7 | 2.9 | 2.8 | 3.2 | 2.6 | 2.9 | 3.1 | 3.3 | a, b, c, e |
| Food Irradiation | 2.8 | 2.6 | 2.9 | 2.7 | 3.1 | 2.5 | 2.9 | 3.0 | 3.2 | a, b, c, e |
| Genet Engr Bacteria | 2.7 | 2.6 | 2.9 | 2.6 | 3.1 | 2.5 | 2.8 | 3.1 | 3.2 | a, b, c, d, e |
| Storms & Floods | 2.7 | 2.5 | 2.8 | 2.6 | 2.9 | 2.5 | 2.8 | 2.6 | 3.0 | a, b, c, e |
| Hi-Volt Power Lines | 2.6 | 2.4 | 2.8 | 2.6 | 2.8 | 2.3 | 2.8 | 2.7 | 2.9 | a, b, c |
| Radon in Home | 2.6 | 2.5 | 2.7 | 2.6 | 2.9 | 2.4 | 2.7 | 2.9 | 3.0 | a, b, c, e |
| VDTs | 2.5 | 2.4 | 2.6 | 2.5 | 2.7 | 2.3 | 2.6 | 2.7 | 2.7 | a, b, c |
| Medical X-Rays | 2.3 | 2.2 | 2.4 | 2.3 | 2.6 | 2.2 | 2.4 | 2.5 | 2.6 | a, b, c, e |
| Commerical Air Travel | 2.3 | 2.2 | 2.5 | 2.3 | 2.6 | 2.2 | 2.4 | 2.6 | 2.7 | a, b, c, e |
| Hazard Index | 3.0 | 2.9 | 3.1 | 3.0 | 3.2 | 2.8 | 3.1 | 3.1 | 3.3 | a, b, c, e |

[a] N = 1,512; all other means based on N = 1,489 (23 respondents for whom race not given were excluded).

[b] All omnibus F tests were significant at p < .001. Tukey HSD test is at p = .05 where: a = white male with white female; b = white male with nonwhite male; c = white male with nonwhite female; d = white female with nonwhite male; e = white female with nonwhite female; and f = nonwhite male with nonwhite female.

Table III. Standardized Regression Coefficients for Prediction of the Hazard Index

| Predictor | Single Variable Regressions | Mulliple Regressions[a] |
|---|---|---|
| Sex | −.29*** | −.27*** |
| Race | .18*** | .15*** |
| White Males vs. Others[b] | .33*** | .31*** |

[a]The following variables were forced into the regression before sex or race or white male/others were entered into the analysis: education, income, perceived control over health risks, perceived importance of high technology for social well being, political orientation (liberal–conservative), age, presence of children under 18 in household, and either sex or race.

[b]White males were coded as 1, all other respondents as 0.

*** $p < .001$







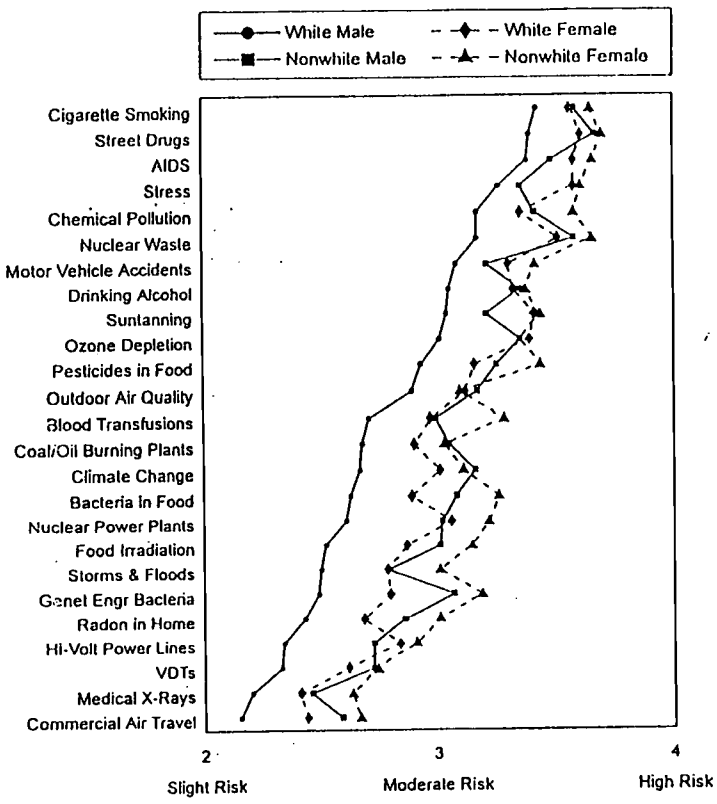


Figure 1. Mean risk perception ratings by race and gender.

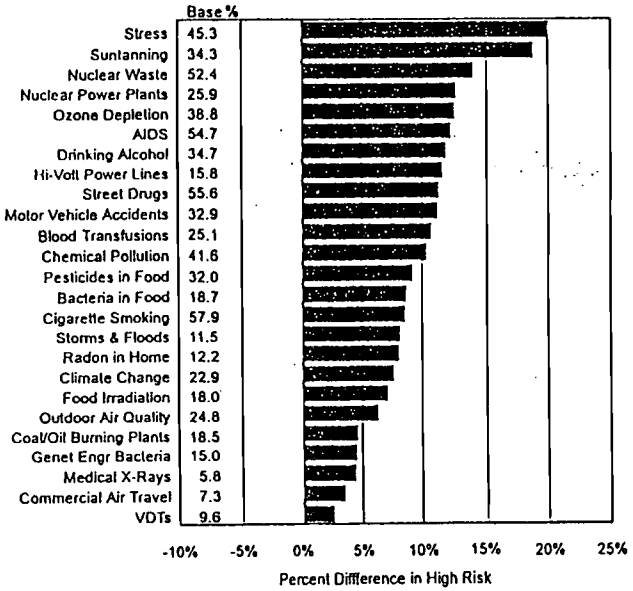


Figure 2. Perceived health risks to American public by gender: Difference between males and females. Base percent equals male high-risk response. Percent difference is female high-risk response minus male high-risk response.





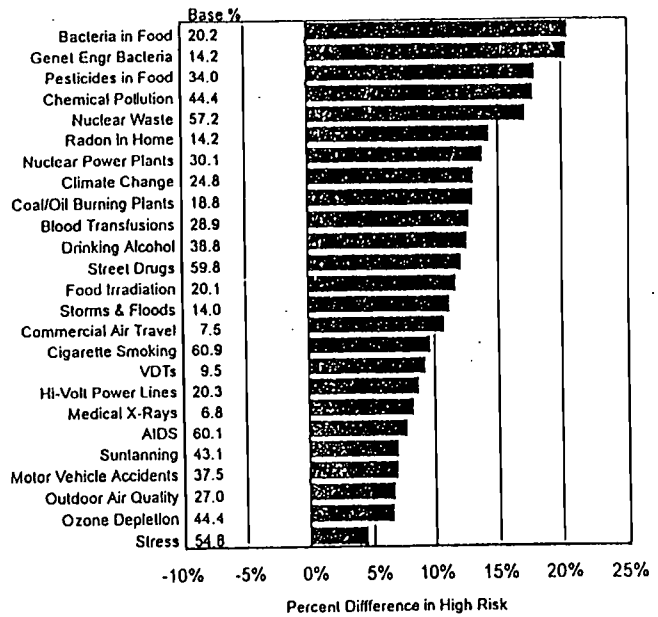


Figure 3. Perceived health risks to American public by race: Difference between whites and nonwhites. Base percent equals white high-risk response. Percent difference is nonwhite high-risk response minus white high-risk response.

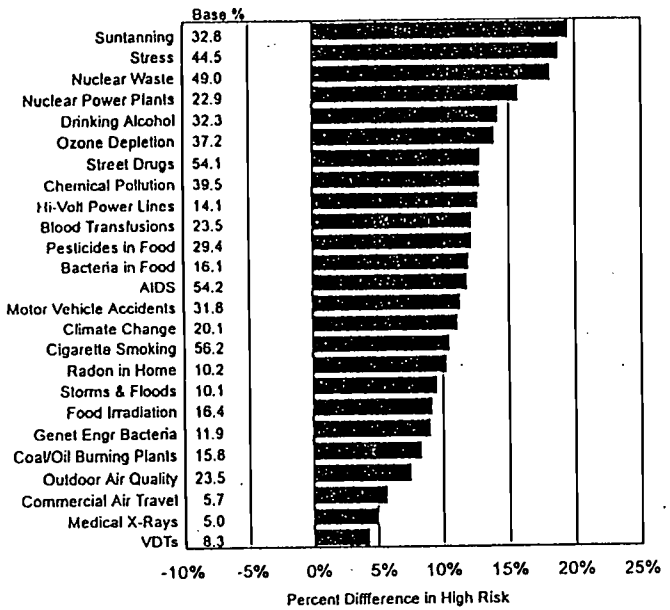


Figure 4. Perceived health risks to American public by white males: Difference between white males and all others. Base percent equals white male high-risk response. Percent difference is others high-risk response minus white male high-risk response.





FOOTNOTE

1. Unless otherwise noted, all comparisons reported in this section are statistically significant at $p < .01$.

# This Changing World

## Environmental hazards: The challenge of change

# Environmental hazards in the 1990s: problems, paradigms and prospects

The United Nations has declared the 1990s the International Decade for Natural Disaster Reduction (IDNDR). The unanimous passage of General Assembly resolution 42/169 on 11 December, 1987, was based on the belief that 'natural' hazards are continuing to pose escalating costs on human societies – the so-called 'natural tax' – through death, destruction, damage and disruption. This view, which was supported by statements such as:

> During the past two decades, natural disasters have been responsible for about 3 million deaths and have adversely affected at least 800 million people through homelessness, disease, serious economic loss and other hardships, including immediate damages in the hundreds of billions of dollars.

very largely reflected increasing awareness of hazard impacts brought about by developments in communications and the media. As a consequence of the quicker and more accurate reporting of disasters, large death tolls in Third World countries came to appear depressingly commonplace in the 1970s and 1980s, with occasional catastrophes such as the Bangladesh floods of 1970 (over 200,000 killed) and the Tangshen (China) earthquake of 1976 (242,000 killed). Especially influential were the improvements in TV technology which brought into western homes distressing images of human suffering, most particularly those created by chronic desertification in the African Sahel. That such events should be occurring at a time when human belief in the power of technology was at its highest, was clearly a challenge that could not be ignored, thereby resulting in the wording of resolution 42/169 (1987):

> to designate the 1990s as a decade in which the international community, under the auspices of the United Nations, will pay special attention to fostering international co-operation in the field of natural disaster reduction.

In view of the apparent disproportionate effect of 'natural disasters' on developing countries, it is of little surprise to note that the objectives of IDNDR, as modified by resolutions 43/202 (1988) and 44/236 (1989), should have subsequently been refocussed towards the needs of the developing world, as is illustrated by the statement that the purpose of the Decade is to:

> reduce through concerted international actions, especially in developing countries, loss of life, property damage and social and economic disruption caused by natural disasters such as earthquakes, windstorms (cyclones, hurricanes, tornadoes, typhoons), tsunamis, floods, landslides, volcanic eruptions, wildfires, grasshopper and locust infestations, drought and desertification and other calamities of natural origin

by the achievement of five goals, the first of which is:

> to improve the capacity of each country to mitigate the effects of natural disasters expeditiously and effectively, paying special attention to assisting developing countries in the assessment of disaster damage potential and in the establishment of early warning systems and disaster-resistant structures when and where needed.

That IDNDR has not achieved the anticipated prominence, profile, and publicity is due largely to the fact that the Decade has been overtaken



David Jones. 1993. Environmental hazards in the 1990s: Problems, paradigms and prospects. *Geography* 78, 2 (April): 161-165. 

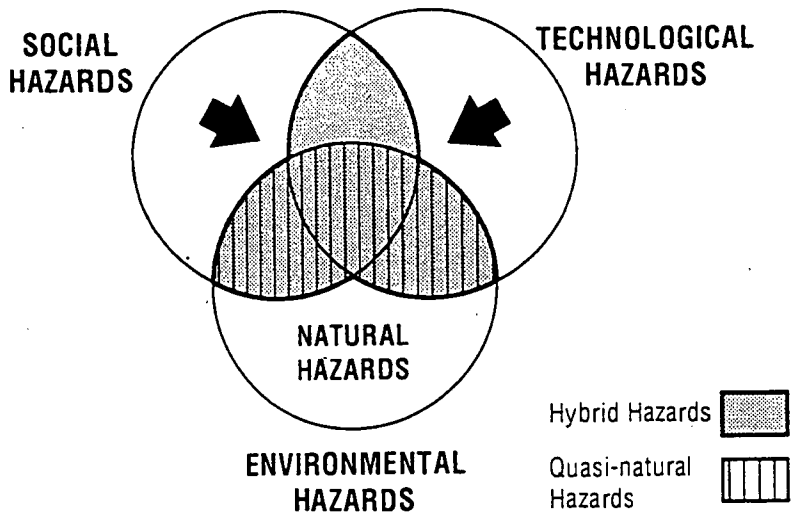


Fig. 1. The Hazard Spectrum. Increasing human influence, coupled with technological development, has resulted in a progressive blurring of the distinctions between natural, social and technological hazards and resulted in the growing variety and significance of quasi-natural and hybrid hazards.

by events. Current high levels of concern over the problematic outcomes of the cumulative, diffuse and insidious 'elusive' hazards of global warming and stratospheric ozone depletion have tended to relegate 'traditional' natural hazards to the status of 'other concerns', at least in the short term. Interest in hazards has also temporarily diminished because much attention has been focussed on the problems caused by the collapse of communism and the world recession. But there are also questions as to whether a Decade is really needed in order to address the threats posed by 'natural' hazards and to what extent the technocentric approach, which emphasises the leading roles of technology and engineering in hazard-loss reduction, is really the best suited for dealing with the problems experienced by developing countries. Indeed, the significance and relative importance of natural hazard losses in the developing world remains a topic of debate, and there is a body of opinion that the debilitating effects of such impacts has sometimes been exaggerated.

Geographers have long had an interest in natural hazards, traditionally defined as "those elements in the physical environment harmful to man (humans) and caused by factors extraneous to him (society)", because of their role as constraints on human activity. It has been normal for geographers to divide hazards into two groups – natural hazards and technological hazards (crashes, explosions, etc.) – but to largely restrict geographic enquiry to the former. In reality, hazard and its more complex product, risk, is ubiquitous and more meaningfully partitioned into three elements: environmental hazards (operating via the physical and biotic environment), technological hazards (emanating from technological structures, processes and products) and social hazards (resulting from human behaviour). These three still form the focus of separate, distinct fields of academic enquiry, but can best be envisaged to merge into a continuum, so that although some events are diagnostic of each of the three specific categories (eg. volcanic eruptions, factory explosions, riots), the majority reflect the variable contribution of more than one of the main factors (Fig. 1) and are better termed quasi-natural or hybrid hazards (eg. alterations in flood hazard due to land-use changes, building collapse in earthquakes, acid rain, desertification, global warming). Thus the term 'natural hazard' has fallen into disrepute, partly because a decreasing number of phenomena fail to reflect the influence of human activities (earthquakes, volcanoes, tropical revolving storms) but mainly because humans contribute greatly to the creation of hazards, and has largely been replaced by such terms as environmental hazards (which can be broadened to include the built environment), geophysical hazards, geohazards (earth hazards), atmospheric hazards, biotic hazards, etc.

Undeniably the most tangible product of IDNDR to date has been the resurgence in academic interest in hazard as testified by the publication of numerous books on hazard of interest to geographers. Prior to 1990 readers were very largely dependent on Frank Lane's colourful catalogue of mayhem entitled *The Elements Rage* (1966), Burton, Kates and White's *The Environment as Hazard* (1978), Whittow's *Disasters* (1980), Hewitt's edited collection of

challenging essays entitled *Interpretations of Calamity* (1983), Cuny's excellent *Disasters and Development* (1983) and Wijkman and Timberlake's perceptive *Natural Disasters: Acts of God or Acts of Man?* (1984). The 'new wave' of publications includes Bryant's *Natural Hazards* (1991), McCall *et al.*'s edited collection *Geohazards* (1992), K. Smith's *Environmental Hazards* (1992) and the Royal Society Report *Risk: Assessment, Perception and Management* (1992), with several others currently in press.

While these new works are to be welcomed, they very largely continue to present the traditional, highly compartmentalised view of hazard which focusses on hazard agents (eg. earthquakes, hurricanes, landslides), thereby emphasising the differences between hazards rather than exploring the similarities that may exist in terms of consequences and managerial responses – a feature that has recently been termed "The Risk Archipelago" (Royal Society, 1992). In addition, there is still a tendency to perpetuate certain misconceptions about environmental hazards (Jones, 1991) by placing too great an emphasis on:

(i) conspicuous, high-energy events which may be dramatic (eg. volcanic eruptions) but are not necessarily particularly significant in terms of hazard losses at global or regional scales, although they obviously attain local importance;

(ii) large-scale impacts, normally described by the imprecisely defined term 'disasters', which are undoubtedly important but merely represent one extreme of a magnitude-frequency spectrum of events which include large numbers of smaller scale, less conspicuous impacts which may, nevertheless, be of considerable cumulative significance and be more readily reduced by management actions;

(iii) death tolls, which may be the easiest loss-statistic to produce and the most readily appreciated, but are increasingly seen to be a poor measure of hazard impact significance because of (i) chance factors in determining death tolls, (ii) the low value attached to life in certain areas and (iii) the effectiveness of measures taken to safeguard lives in advanced societies which have led to disproportionate reductions in death tolls compared with economic losses (see Smithson, this issue).

(iv) the unpredictability of 'natural' events, thereby emphasising the powerlessness of human societies when faced with the violence of nature. This is to a large extent untrue now, for most hazards are predictable in terms of defining the probabilities of occurrence at particular locations, although defining the precise location, timing and magnitude of a particular event (forecasting) is often extremely difficult and uncertain; thus costly hazard impacts are better considered as unanticipated rather than unexpected; and

(v) the value of the technocentric approach to hazard mitigation, which emphasises the primary roles of technology and engineering in reducing losses through forecasting, control and defence.

The last mentioned, sometimes referred to as the 'technological fix' or 'engineering fix', has been the subject of much debate in recent years, for there is considerable disagreement as to the long-term effectiveness of technocentric solutions when applied without the supporting benefit of socio-economic adjustments. Two fundamentally opposing views (paradigms) have been identified, to which a third may be in the process of evolving. The traditional approach grew out of the development of natural hazards research in the United States. This adopted a human-ecological approach to examine the apparent mismatch between the 'human use system' and the 'natural events system'. The result was the 'Behavioural Paradigm' which envisages 'natural' hazard impacts as the consequence of the lack of adjustment between human societies and the physical environment: a mismatch that is best minimised by focussing attention on the cause of losses (the physical environment) and, through the use of science and technology, limiting impacts on society by the development of warning systems, the creation of engineered defences/protection and the construction of durable structures. The universal value of this technocentric approach came to be disputed about a decade ago (Hewitt, 1983), when the emphasis shifted to interpreting hazard impacts as the consequence of the interaction between physical phenomena and the vulnerable facets of society (Fig. 2). As vulnerability is determined to a very large extent by socio-economic and political factors, the awareness of social structures as being a significant contributor to hazard losses resulted in the establishment of the competing 'Structural Paradigm'. Originally this was focussed on local and national structures, but more recently the recognition that international factors play a role in local vulnerability, especially in the developing world, has resulted in an expanded version of the structural approach, known as the 'Political Economy Paradigm'. Such developments in thinking bring into question the focus of

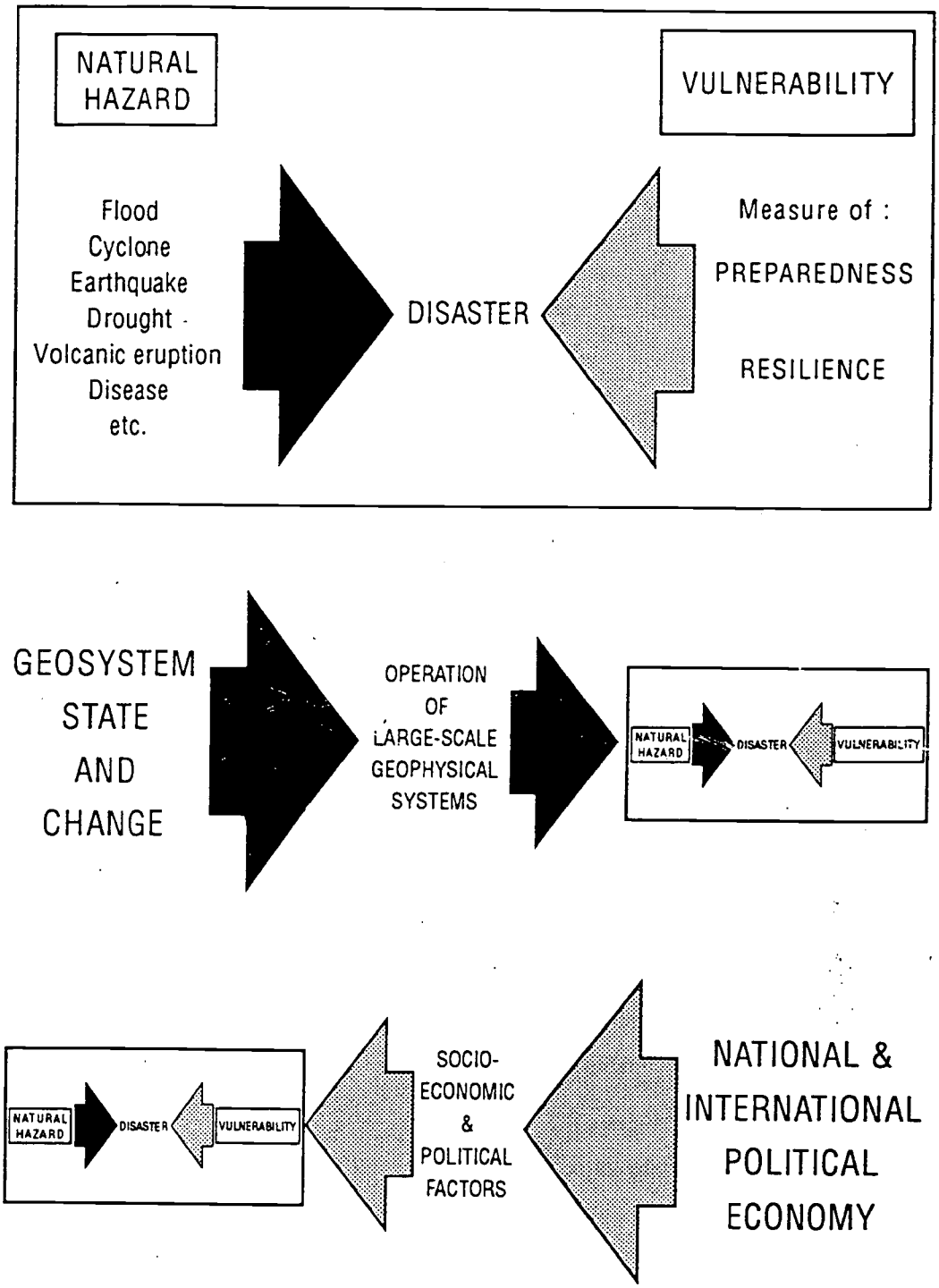


Fig. 2. Hazard impacts result from the interaction between hazard agents and the vulnerability of society. The traditional Behavioural Paradigm focuses on the physical causes of hazard impacts (central diagram) but has recently been opposed by the Structural Paradigm (bottom diagram) which emphasises the role of society in generating losses. Clearly future developments will depend on the balancing of the two parts of the 'hazard equation'.

IDNDR, for while science, technology and engineering have obvious great value in reducing hazard losses, their sustainable use in the developing world will only be achieved, it is often argued, by socio-political changes that contribute towards a reduction in vulnerability.

Environmental hazards continue to be a fruitful arena for geographical enquiry because of the way they interrelate the physical and human branches of the subject. The group of articles that follow exemplify many of the points raised above. They include examples of extremely violent events (earthquakes, tropical revolving storms, tornadoes) and the so-called 'quiet hazards' (desertification, radon), impacts that are extensive (earthquakes, desertification) as well as localised (landslides, tornadoes), rapid onset phenomena (tornadoes, earthquakes) and the slow onset hazards (desertification). In addition, the articles include discussion of both long-recognised hazards and newly-identified threats (radon), as well as environmental hazards that operate with disregard to human activity (earthquakes) and those whose existence has been largely determined by humans (desertification). While some of the contributions focus on the developing world, others emphasise developed countries where the costs of environmental hazards remain significant, even though death tolls are usually low. What the set as a whole reveal is that knowledge of hazard impacts remains poor, explanations of hazardous events vary and that strategies for resolving the problems are the subject of much debate. However, the common thread running through all the discussions is that hazard-loss reduction strategies cannot rely on technological solutions alone but must involve some adjustments within human societies.

**Further Reading**


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# Gender, Race, and Perception of Environmental Health Risks

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This paper reports the results of a national survey in which perceptions of environmental health risks were measured for 1275 white and 214 nonwhite persons. The results showed that white women perceived risks to be much higher than did white men, a result that is consistent with previous studies. However, this gender difference was not true of nonwhite women and men, whose perceptions of risk were quite similar. Most striking was the finding that white males tended to differ from everyone else in their attitudes and perceptions—on average, they perceived risks as much smaller and much more acceptable than did other people. These results suggest that sociopolitical factors such as power, status, alienation, and trust are strong determiners of people's perception and acceptance of risks.

KEY WORDS: Gender; race; risk perception; environmental equity.

## 1. INTRODUCTION

Research has demonstrated that perceptions of risk are influenced by the qualities of a hazard—whether exposure to it is voluntary or controllable, whether its adverse consequences can be catastrophic, whether its benefits are distributed fairly among those who bear the risks, and so on.[1] Few studies, however, have examined in any detail the characteristics of the risk perceivers themselves. One exception is that sizable differences between risk perceptions of men and women have been documented in several dozens of studies. Men tend to judge risks as smaller and less problematic than do women.[2-13]

More recently, race and risk have become an issue as it has become apparent that people of color are subjected to higher levels of exposure from many toxic substances.[14] The conditions leading to these disproportionate exposures have been labeled "environmental racism."[15] Except for a study by Savage,[16] there are few data regarding how people of color perceive the risks to which they are exposed. Savage found that blacks felt more threatened than whites by each of four hazards: commercial aviation accidents, home fires, automobile accidents, and stomach cancer. Women also perceived themselves as threatened by these hazards to a greater extent than did men.

A recent survey of the American public's perceptions of risk interviewed more than 200 people of color. The present study reports the results of this survey, with particular emphasis on the relationships among race, gender, and risk perceptions.

## 2. METHOD

The data for the present study come from a national survey in the United States in which a random sample of 1512 English-speaking persons were interviewed by telephone. The interviews were conducted between November 21, 1992, and January 16, 1993. The response rate was 50.7%. The objective of the study was to obtain information on people's attitudes, perceptions, values,

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knowledge, and beliefs about environmental health risks. The survey instrument contained 155 items including ratings of environmental risks, attitude and opinion questions on a variety of health issues such as the riskiness of one's local environment, attitudes toward government and business, general attitudes called *worldviews*, personal risk-taking behaviors, and personal and demographic characteristics of the respondents and their households.

Race and ethnicity were combined in one question for the survey: "What is your race or ethnic background? Do you consider yourself Hispanic, white, black, Asian, or American Indian?" This procedure relies on self-definition, which as Cooper points out is the "only legal basis for racial classification" in the United States.[17] Twenty-three persons did not answer this question while 1275 identified themselves as white and 214 selected one of the other choices. Those who did answer were distributed as shown in Table I.

The characteristics of the present sample can be compared roughly to the data from the U.S. Bureau of the Census *1990 Census of Population*, which assessed 93 million households. White households made up 86.0% of this total, blacks 11.3%, and other nonwhites 2.8%. Hispanics (who can be of any race) were 6.3% of the households. Population counts may differ from household counts because of different living arrangements and household sizes across race and ethnic categories. Therefore, population estimates for race and ethnicity are complex and inexact, especially when they are combined.[18,19] Taking these considerations into account, our survey sample may have a slightly higher percentage of whites than the general population. Because the nonwhite respondents were required to be English-speaking persons, they may be somewhat more similar to whites than the general nonwhite population would be.

## 3. RESULTS

Respondents were asked to rate the public health risks associated with each of 25 hazards. These hazards included a diverse set of technologies (e.g., nuclear power, commercial air travel), lifestyle risks (e.g., cigarette smoking, drinking alcohol), and environmental conditions (e.g., ozone depletion, radon). The response scale went from "almost no health risk" to "slight health risk," "moderate health risk," and "high health risk." These response categories were coded 1–4, respectively, and the coded scores were averaged across respondents and across hazards in the analysis reported below.

Table II shows the mean scores for the total sample and for subgroups defined by race and gender. A *hazard index* was created by averaging the ratings across the 25 items. An omnibus $F$ test was conducted for each hazard item to evaluate the statistical significance of differences among the four subcategories of race and gender (white male, white female, nonwhite male, and nonwhite female). As shown in Table I, those who identified themselves as Hispanic, black, Asian, or American Indian were included in the nonwhite category. For those cases where the omnibus $F$ test was significant at $p < .05$, a Tukey test was conducted. The pairs of groups that differed significantly ($p < .05$) on the Tukey test are identified by code (a–f) as defined in Table II, footnote *b*. The means for each of the four race/gender subgroups also are presented in Fig. 1.

The data in columns 2 and 3 in Table II show the consistent difference between risk perceptions of men and women that has been documented in previous studies. Columns 4 and 5 in the table show that the nonwhite respondents had consistently higher mean ratings of perceived risk than did white respondents. This finding is similar to Savage's finding of higher perceived vulnerability to hazards among blacks.[16] But the most striking result in these data is clear immediately from a glance at Fig. 1. White males produced mean risk-perception ratings that were consistently much lower than the means of the other three groups. Nonwhite males and females showed only one significant difference (males have lower ratings on stress). Nonwhite males often had higher mean ratings than white females (significantly higher for genetically engineered bacteria).

Nonwhite females tended to have higher mean risk ratings (significantly different statistically from white females on 10 of the items). White and nonwhite males differed significantly on 20 of the 25 items. Significant differences were observed for all 25 items between white males and white females and between white males and nonwhite females.

### 3.1. Risk Perception and Gender

Figure 2 provides another perspective on the gender differences by showing the percentage of men and women who rated a hazard as a "high risk." All differences are to the right of the 0% mark, indicating that the percentage of high-risk responses was greater for women on every item.

Table I. Survey Sample by Gender and Race

| Total sample | | | | Nonwhite sample | | | |
|---|---|---|---|---|---|---|---|
| | Male | Female | Total | | Male | Female | Total |
| White | 616 | 659 | 1275 (85.6%) | Hispanic | 30 | 28 | 58 (3.9%) |
| Nonwhite | 97 | 117 | 214 (14.4%) | Black | 46 | 67 | 113 (7.6%) |
| Total | 713 | 776 | | Asian | 8 | 7 | 15 (1.0%) |
| | | | | American Indian | 13 | 15 | 28 (1.9%) |
| | | | | Total | 97 | 117 | |

Table II. Perceived Risk to American Public by Gender and Race (Mean Scores)

| | | | | | | White | | Nonwhite | | Tukey post hoc paired |
|---|---|---|---|---|---|---|---|---|---|---|
| Hazard | Overall[a] | Male | Female | White | Nonwhite | Male | Female | Male | Female | comparison[b] |
| Street drugs | 3.5 | 3.4 | 3.6 | 3.5 | 3.7 | 3.4 | 3.6 | 3.7 | 3.7 | a,b,c |
| Cigarette smoking | 3.5 | 3.4 | 3.6 | 3.5 | 3.6 | 3.4 | 3.6 | 3.6 | 3.7 | a,c |
| AIDS | 3.5 | 3.4 | 3.6 | 3.5 | 3.6 | 3.4 | 3.6 | 3.5 | 3.7 | a,c |
| Stress | 3.4 | 3.3 | 3.6 | 3.4 | 3.5 | 3.3 | 3.6 | 3.4 | 3.6 | a,c,d,f |
| Nuclear waste | 3.4 | 3.2 | 3.5 | 3.3 | 3.6 | 3.2 | 3.5 | 3.6 | 3.7 | a,b,c |
| Chemical pollution | 3.3 | 3.2 | 3.4 | 3.3 | 3.5 | 3.2 | 3.4 | 3.4 | 3.6 | a,b,c,e |
| Suntanning | 3.2 | 3.1 | 3.4 | 3.2 | 3.3 | 3.0 | 3.4 | 3.2 | 3.4 | a,c |
| Ozone depletion | 3.2 | 3.1 | 3.4 | 3.2 | 3.3 | 3.0 | 3.4 | 3.4 | 3.4 | a,b,c |
| Drinking alcohol | 3.2 | 3.1 | 3.3 | 3.2 | 3.6 | 3.1 | 3.3 | 3.4 | 3.4 | a,b,c |
| Motor vehicle accidents | 3.2 | 3.1 | 3.3 | 3.2 | 3.3 | 3.1 | 3.3 | 3.2 | 3.4 | a,c |
| Pesticides in food | 3.1 | 3.0 | 3.2 | 3.0 | 3.4 | 2.9 | 3.2 | 3.3 | 3.4 | a,b,c,e |
| Outdoor air quality | 3.0 | 2.9 | 3.1 | 3.0 | 3.1 | 2.9 | 3.1 | 3.2 | 3.1 | a,b,c |
| Blood transfusions | 2.9 | 2.7 | 3.0 | 2.8 | 3.2 | 2.7 | 3.0 | 3.0 | 3.3 | a,b,c,e |
| Climate change | 2.9 | 2.7 | 3.0 | 2.8 | 3.1 | 2.7 | 3.0 | 3.2 | 3.1 | a,b,c |
| Nuclear power plants | 2.9 | 2.7 | 3.1 | 2.8 | 3.1 | 2.6 | 3.1 | 3.0 | 3.2 | a,b,c |
| Coal/oil plants | 2.8 | 2.7 | 2.9 | 2.8 | 3.0 | 2.7 | 2.9 | 3.1 | 3.0 | a,b,c |
| Bacteria in food | 2.8 | 2.7 | 2.9 | 2.8 | 3.2 | 2.6 | 2.9 | 3.1 | 3.3 | a,b,c,e |
| Food irradiation | 2.8 | 2.6 | 2.9 | 2.7 | 3.1 | 2.5 | 2.9 | 3.0 | 3.2 | a,b,c,e |
| Genet engr bacteria | 2.7 | 2.6 | 2.9 | 2.6 | 3.1 | 2.5 | 2.8 | 3.1 | 3.2 | a,b,c,d,e |
| Storms and floods | 2.7 | 2.5 | 2.8 | 2.6 | 2.9 | 2.5 | 2.8 | 2.8 | 3.0 | a,b,c,e |
| Hi-volt power lines | 2.6 | 2.4 | 2.8 | 2.6 | 2.8 | 2.3 | 2.8 | 2.7 | 2.9 | a,b,c |
| Radon in home | 2.6 | 2.5 | 2.7 | 2.6 | 2.9 | 2.4 | 2.7 | 2.9 | 3.0 | a,b,c,e |
| VDTs | 2.5 | 2.4 | 2.6 | 2.5 | 2.7 | 2.3 | 2.6 | 2.7 | 2.7 | a,b,c |
| Medical X-rays | 2.3 | 2.2 | 2.4 | 2.3 | 2.6 | 2.2 | 2.4 | 2.5 | 2.6 | a,b,c,e |
| Commercial air travel | 2.3 | 2.2 | 2.5 | 2.3 | 2.6 | 2.2 | 2.4 | 2.6 | 2.7 | a,b,c,e |
| Hazard index | 3.0 | 2.9 | 3.1 | 3.0 | 3.2 | 2.8 | 3.1 | 3.1 | 3.3 | a,b,c,e |

[a] $N = 1512$; all other means based on $N = 1489$ (23 respondents for whom race not given were excluded).

[b] All omnibus $F$ tests were significant at $p < .001$. Tukey HSD test is at $p < .05$, where a = white male with white female, b = white male with nonwhite male, c = white male with nonwhite female, d = white female with nonwhite male, e = white female with nonwhite female, and f = nonwhite male with nonwhite female.

Many earlier studies have found that women see risks as higher than men for nuclear technologies: nuclear power, nuclear waste, and nuclear weapons. In the present survey, perceptions of risk are higher for women for every hazard studied. This parallels a recent Canadian study in which women provided higher risk ratings

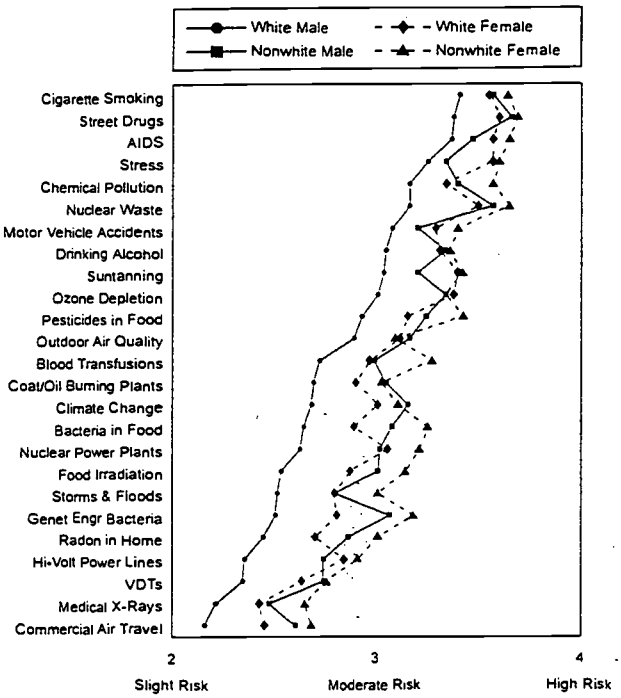


Fig. 1. Mean risk perception ratings by race and gender.

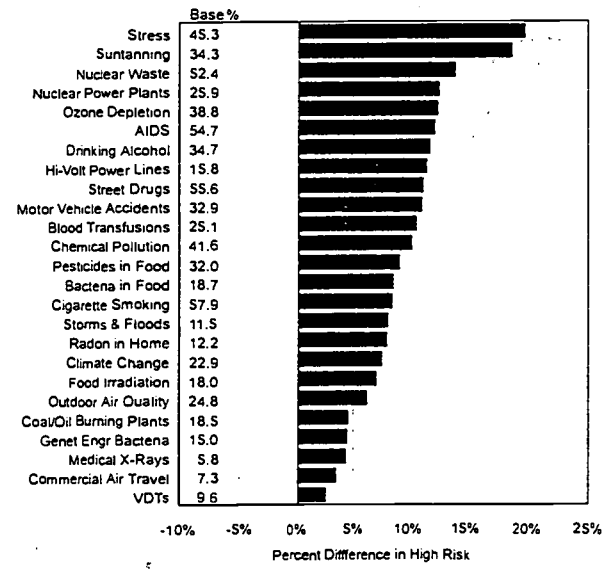


Fig. 2. Perceived health risks to American public by gender: difference between males and females. Base percentage equals male high-risk response. Percentage difference is female high-risk response minus male high-risk response.

for 37 of 38 hazards studied (heart pacemakers were the sole exception), including all of the items shown in Fig. 2.[9]

A number of hypotheses have been put forward to explain the differences in risk perception between men and women. One approach has been to focus on biological and social differences. For example, women have been characterized as more concerned about human health and safety because they give birth and are socialized to nurture and maintain life.[12] They have been characterized as physically more vulnerable, for example to violence such as rape, and this may sensitize them to other risks.[20,21] The combination of biology and social experience has been put forward as the source of a "different voice" that is distinct to women.[22,23]

A lack of knowledge and familiarity with science and technology has also been suggested as a basis for these differences, particularly with regard to nuclear and chemical hazards. Women are discouraged from studying science, and there are relatively few women scientists and engineers.[24] Firestone[25] suggests that women may distrust what are perceived as male-dominated technologies. However, this does not explain why the difference extends to nontechnological hazards (e.g., AIDS, alcohol). Moreover, Barke *et al.*[26] have found that women physical scientists perceive risks from nuclear technologies as higher than do men physical scientists. Certainly these women scientists are knowledgeable about technology.

In general, these explanations have attempted to determine what makes women different and to understand how conditions of biology, risk experience, socialization, or psychology account for the unwillingness of women, when compared to men, to accept the levels of risk recommended by advocates and managers of technology. In this context, we note that risk-acceptance advocates are predominantly white males.

### 3.2. Risk Perception and Race

The practice of siting hazardous and noxious waste facilities in areas with significant or majority nonwhite population has led to concerns about environmental equity and environmental racism.[14,15,27,28] Low income, low levels of education, and other social disadvantages tend to characterize many of these communities. Thus racial and ethnic factors are combined with economic vulnerabilities and political weakness as characteristics of communities that may be targeted as sites for facilities that are unacceptable in other locations.

The environmental and health-risk concerns expressed by people of color are not restricted to the siting of new facilities. Other important issues include pollution of residential neighborhoods and hazards in the

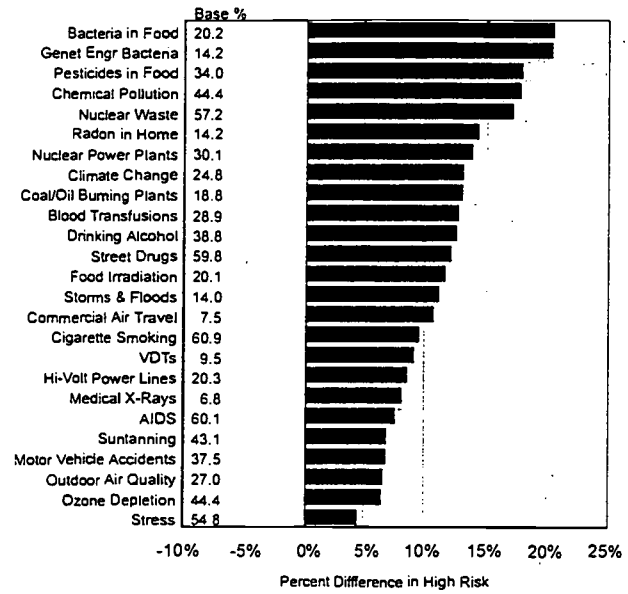


Fig. 3. Perceived health risks to American public by race: difference between whites and nonwhites. Base percentage equals white high-risk response. Percentage difference is nonwhite high-risk response minus white high-risk.

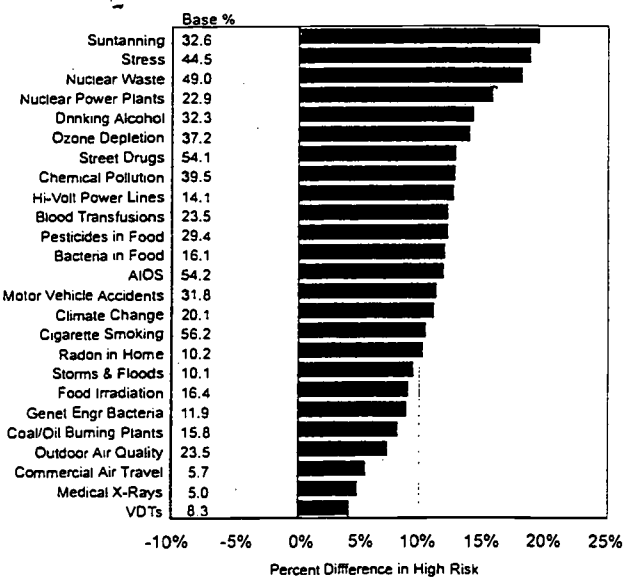


Fig. 4. Perceived health risks to American public by white males: difference between white males and all others. Base percentage equals white male high-risk response. Percentage difference is others high-risk response minus white male high-risk response.

workplace, for example, pesticide exposures to agricultural workers.[29] Exposure to lead and the incidence of lead poisoning have been called one of the nation's most serious health threats to children and one that is much more common for children of color than for white children.[30] Federal programs to clean up existing Superfund sites may favor white communities in preference to addressing the problems in communities with large nonwhite populations.[31] In response to one statement in the present survey, "There are serious environmental health problems where I live," 45% of the white respondents agreed or strongly agreed. The rate of agreement for nonwhites was 20.5% higher. The difference between whites and blacks was even greater, 25.8%. Hispanics agreed 4.4% more frequently than blacks and 30.2% more frequently than whites.

Researchers active in the study of environmental justice have viewed the forced physical association by people of color with a wide range of environmental hazards as evidence of structural racism.[15] The dangers of violence, drugs, alcohol, and lower socioeconomic status compound the risks, leading to considerably higher mortality for nonwhites.[32]

The concern about technological and environmental health risks shown by people of color is clearly documented in the present survey data. Figure 3 shows the difference between white people and people of color in rating the hazard items as "high health risks" to the American public. The percentage of high-risk responses is greater among people of color on every item. Nonwhites were particularly more concerned about bacteria in food, genetically engineered bacteria, pesticides in food, and pollution from chemical and nuclear wastes. The differences were smaller for stress, ozone depletion, and outdoor air quality. The differences between white and nonwhite respondents might have been even greater if nonwhites had been asked to rate the risks to people like themselves, rather than to the American public as a whole.

### 3.3. Risk Perception Among White Males

The difference between white males and all other respondents in use of the high-risk response is shown in Fig. 4. White males were always less likely to rate a hazard as posing a "high risk." This was particularly true for suntanning, stress, nuclear power plants, nuclear waste, drinking alcohol, and ozone depletion. This tendency was smallest for video display terminals and medical X-rays.

Whereas Fig. 4 reflects high-risk responses, we have shown earlier in Fig. 2 that white males have substantially lower mean responses on the risk-perception questions—both for individual items and for the 25-item hazard index. When we examined the entire distribution

Table III. Standardized Regression Coefficients for Prediction of the Hazard Index

| Predictor | Single variable regression | Multiple regression[a] |
|---|---|---|
| Sex[b] | −.29* | −.27* |
| Race[c] | .18* | .15* |
| White males vs others[d] | .33* | .31* |

[a] The following variables were forced into the regression before sex or race or white male/others were entered into the analysis: education, income, perceived control over health risks, perceived importance of high technology for social well-being, political orientation (liberal–conservative), age, presence of children under 18 in household, and either sex or race.

[b] Females were coded as 0, men as 1.

[c] Whites were coded as 0, nonwhite as 1.

[d] White males were coded as 0; all other respondents as 1.

* $p < .001$.

of scores on the hazard index, we observed that white males accounted for more than two-thirds of the respondents in the lower quartile of that distribution but that some white males were also found in the high-risk perception portion of the distribution. This prompted us to ask, "What differentiates those white males who are most responsible for the 'white-male effect' from the rest of the sample, including other white males who see risks as relatively serious?"

To answer this question, we selected a subgroup of 246 white males at the low-risk end of the hazard index to compare with the 370 other white males and the 873 females and nonwhite males in the sample. The number 246 was arrived at by starting with the lowest-scoring white male on the hazard index and moving up the distribution, adding white males until the mean score on the hazard index for the remaining white males matched the mean score for all other persons (all females and all nonwhite males) in the sample. This occurred when 246 white males were selected for the low-risk perception white male subgroup.

We next compared the attitudes of these 246 white males with the attitudes of the 1243 other respondents in our sample. This comparison group of other respondents included 101 white females, 16 nonwhite males, and 7 nonwhite females with scores on the hazard index that were lower than the score of the highest-scoring person in the subgroup of 246 white males. The comparisons reported below are statistically significant at $p < .01$.

The group of white males with the lower risk-perception scores were better educated (42.7% college or postgraduate degree, vs 26.3% in the other group), had higher household incomes (32.1% above $50,000, vs 21.0%), and were politically more conservative (48.0% conservative, vs 33.2% in the other group). There was no difference between this white male subgroup and the others with regard to age.

Turning to attitudes, the low-risk perception subgroup of white males was *more likely* than the others to

- agree that future generations can take care of themselves when facing risks imposed on them from today's technologies (64.2 vs 46.9%).
- agree that if a risk is very small it is OK for society to impose that risk on individuals without their consent (31.7 vs 20.8%).
- agree that science can settle differences of opinion about the risks from nuclear power (61.8 vs 50.4%).
- agree that government and industry can be trusted with making the proper decisions to manage the risks from technology (48.0 vs 31.1%).
- agree that we can trust the experts and engineers who build, operate, and regulate nuclear power plants (62.6 vs 39.7%).
- agree that we have gone too far in pushing equal rights in this country (42.7 vs 30.9%).
- agree with the use of capital punishment (88.2 vs 70.5%).
- disagree that technological development is destroying nature (56.9 vs 32.8%).
- disagree that they have very little control over risks to their health (73.6 vs 63.1%).
- disagree that the world needs a more equal distribution of wealth (42.7 vs 31.3%).
- disagree that local residents should have the authority to close a nuclear power plant if they think it is not run properly (50.4 vs 25.1%).
- disagree that the public should vote to decide on issues such as nuclear power (28.5 vs 16.7%).

In sum, the subgroup of white males who perceive risks to be quite low can be characterized by trust in institutions and authorities and a disinclination toward giving decision-making power to citizens in areas of risk management.

### 3.4. Analysis of Other Social and Demographic Variables

Gender and race are correlated with other variables such as income, education, perceived control over health risks, political orientation, and so on. Can the observed association among race, gender, and risk perception be

explained by these other variables? To answer this question, we conducted a number of stepwise multiple regression analyses in which these other variables, plus age, perceived importance of technology, and the presence of children in the household, were forced into the equation to predict the hazard index before either gender, race, or "white male" were put into the equation. The results are shown in Table III.

Gender, race, and "white male" remained highly significant predictors of the hazard index, even when all of these other variables were controlled statistically. Moreover, the standardized regression coefficients for gender, race, and "white male" were reduced very little by the inclusion of the other variables into the prediction equation. To the extent that this analysis adequately controlled for factors such as income, education, and so on, these results show that these factors do not account for the observed effects of race and gender on perceived risks.

## 4. DISCUSSION

There are two new and important results in these data. First, nonwhite males and females are much more similar in their perceptions of risk than are white males and females. Second, white males stand out from everyone else in their perceptions and attitudes regarding risk. These results raise new questions. What does it mean for the explanations of gender differences when we see that the sizable differences between white males and white females do not exist for nonwhite males and nonwhite females? Why does a substantial percentage of white males see the world as so much less risky than everyone else sees it?

Obviously, the salience of biology is reduced by these data on risk perception and race. Biological factors should apply to nonwhite men and women as well as to white people. The present data thus move us away from gender and toward sociopolitical explanations. Perhaps white males see less risk in the world because they create, manage, control, and benefit from so much of it. Perhaps women and nonwhite men see the world as more dangerous because in many ways they are more vulnerable, because they benefit less from many of its technologies and institutions, and because they have less power and control. However, our survey data do not allow us to fully test these alternative explanations. Further research is needed, focusing on the role of power, status, alienation, trust, and other sociopolitical factors, in determining perception and acceptance of risk.

Inasmuch as these sociopolitical factors shape public perception of risks, we can see why traditional attempts to make people see the world as white males do, by showing them statistics and risk assessments, are unlikely to succeed. The problem of risk conflict and controversy goes beyond science. It is deeply rooted in the social and political fabric of our society. Our analysis points to the need for a fairer and more equitable society, as well as for fairer processes for managing risk. If we create such a society, environmental racism will give way to environmental equity.

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